MEMOIRS OF THE MELBOURNE MUSEUM

ILLUSTRATIVE OF THE
NATURAL AND APPLIED SCIENCES, AND OF THE GEOLOGICAL SURVEY OF VICTORIA, AS REPRESENTED
BY THE COLLECTIONS IN THE NATIONAL MUSEUM.

EDITED BY PROFESSOR McCOY, DIRECTOR. [**No. 1.**

SECTION **B.—Catalogues of Museum.**

DESCRIPTIVE CATALOGUE

OF THE

MINING, METALLURGICAL, GEOLOGICAL, AND AGRICULTURAL MODELS

IN

THE NATIONAL MUSEUM, MELBOURNE.

PART I.

§ **A.**—EXPLORATION OF THE SOIL.

Melbourne:
BY AUTHORITY: JOHN FERRES, GOVERNMENT PRINTER.
MAY BE HAD OF ALL BOOKSELLERS.

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CONTENTS

OF

DESCRIPTIVE CATALOGUE

OF THE

Mining, Metallurgical, Geological, and Agricultural Models

IN THE

NATIONAL MUSEUM, MELBOURNE.

[The object the Director had in view, in bringing together this Collection, was to show how all the branches of the Natural Sciences, illustrated in the Zoological, Palæontological, and Mineralogical sections of the Melbourne National Museum, bore upon Geology, and the application of economic geology to two of the useful arts—Mining and Agriculture—one or both of which are now very commonly taught in the modern universities of the Continent and America, as well as in the Queen's University in Ireland, and several colleges of agriculture and mining schools.

The following arrangement (which has been adopted also in the Museum) is that which would be followed by a systematic lecturer on mining, if a Mining School were to be established in Victoria, by taking advantage of the immediate proximity of the National Museum to the Lecture Rooms of the University in which eight out of the ten required Courses of Lectures and Demonstrations of the Government School of Mines, Jermyn street, London, are already given.]

PART I.

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§ B.—Excavation of the Soil.

§ C.—Timbering and Masonry.

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13,100	Model of Hot-blast Stove (Luft-Erwärmungs Apparat).
5,867	Model of Tilt Hammer (Schwanzhammer).
13,091	Model of Lift Forge Hammer (Aufwerfhammer).
13,092	Model of Front Forge Hammer (Stirnhammer).
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10,762–813	Fifty-two Specimens and Samples, showing all the stages of the Metallurgical processes employed in the Royal Saxon Lead and Silver Smelting Works at Freiberg.
10,818–847	Twenty-nine Specimens illustrating several raw Iron Ores, and the successive products of the Iron Smelting process, at the Saynerhütte, Muhlhofen, *a* 1, R, and the mines Georg and Luisa, at Horhausen, Germany.
22,433–450	Eighteen specimens of raw materials and products illustrative of the Silesian process for extracting Zinc.

(*For other Metallurgical Specimens, and Geological, Agricultural, and Miscellaneous Models*, see *Appendix*.)

DESCRIPTIVE CATALOGUE, ETC.

PART I.

Models referring to the Exploration and Working of Mines.

CHAPTER I.

§ A.—EXPLORATION OF THE SOIL

(A *a*.)—IMPLEMENTS USED IN THE EXCAVATION OF UNDERGROUND WORKS AND OPEN WORKINGS, AND THEIR APPLICATION.

(A *b*.)—IMPLEMENTS AND MACHINERY USED IN BORING FOR SOLID MINERALS AND WATER.

THE first knowledge to be acquired in practical mining is that of the methods by which the miner severs portions of the rocks from the whole mass of the earth. The whole of this particular branch of work, termed "Häuer & Gewinnungs arbeit" by the German miner, was originally divided by Werner into five classes, according to the difference in the condition of the rocky masses to be worked and the different tools and methods of work applied, viz.:—

1. *Loose Masses* (Rolliges Gebirge), comprising loose earth, sand and sandy gravels, shingles, &c., or all recent deposits, which can be worked by means of the shovel, scraper, and trough.
2. *Mild Masses* (Mildes Gebirge), or such rock masses as do not strike fire with steel. To these belong coal, rocksalt, clay-slate, older limestones, chalk, marls, gypsum, and alluvial deposits, &c., all of which can be worked with the pick, sledge, gadze, and crowbar.
3. *Tractable Rocks* (Gebräches or Geschmeidiges Gestein), or rock masses which, although they may yield sparks with steel, do not possess any great degree of hardness, such, for instance, as marble, serpentine, sandstones, copperslates, marlstones, all spathose minerals except

felspar and heavy spar, many crystalline rocks in half-decomposed condition, as granite, gneiss, mica-slate, &c., and many metallic minerals as galena, zincblende, copper pyrites, and spar-iron ore. For working this class of rocks the stone pick and crowbar are the tools almost exclusively applied, although the use of powder is frequently adopted.

4. *Tenaceous Rocks* (Zähes & Festes Gestein), or rock masses which can only be worked by blasting operations. They yield sparks when struck with steel, and consist of all hard quartzose rocks, granite, porphyry, basalt, magnetic and hematitic iron ores, copper, iron, and arsenical pyrites, and all ores breaking in with quartz and other hard gangue or matrix.
5. *Very Hard Rocks* (Höchst Festes Gestein), to which the pure quartz belongs, when accompanying and closely mixed with the tin, lead, fahl and zinc-ores. These masses must be first softened and broken up by the action of fire before any of the ordinary tools and appliances can be brought into successful operation.

According to these five divisions, the methods of working may be thus recapitulated :—

1. Scrape and shovel work (Wegfüllarbeit).
2. Stone-pick work (Keilhauarbeit).
3. Gadze and mallet work (Schlägel und Eisenarbeit).
4. Blasting and Quarrying (Sprengarbeit).
5. The heating or firing process (Feuersetzen), viz., application of fire against the face of the rocks by means of stoves constructed for that purpose.

The following descriptive lists contain the principal mining tools, more or less corresponding to these five distinct works, as well as machines substituted for them, and working sections.

The tools are arranged in sets as employed in different countries, and their characteristic dimensions, and often the weights, are carefully given in English measure. The English draining tools, although originally invented for agricultural purposes, are also ranged with the mining tools, as they may be found extremely useful and employed with great advantage in overground workings. Nearly all the objects in the list are represented in the accompanying lithographed plates. The marginal numbers are those attached to the objects in the Museum according with the office register. The few tools or machines described in the Catalogue without numbers are in progress of construction.

IMPLEMENTS USED FOR ALLUVIAL GOLD WASHING IN VICTORIA.

(Museum Nos. 11,250–58, Plate V., Figures 2 to 9.)

Museum No.

11,250 (1) MINER'S PICK (Plate V., fig. 2), for sinking and overground work: double-armed. *Head*, 22″; *handle*, 2′ 8″; *section of arms*, 1″ × 1$\frac{3}{8}$″ (about 2″ beyond centre); *weight*, 7$\frac{1}{4}$ lbs. The eye is lens-shaped, 3″ × 2″ above, tapering to 2$\frac{1}{4}$″ × 1$\frac{3}{8}$″ at a height of 2$\frac{1}{2}$″, of which the lower part is formed by round cheeks projecting about 1$\frac{1}{4}$″; one arm is drawn in to a point, the other having a horizontal $\frac{5}{4}$″ cutting edge.

11,251 (2) MINER'S SINKING PICK (Plate V., fig. 4), double-armed. *Head*, 18″; *handle*, 21″; *section of arms*, $\frac{3}{4}$″ × 1$\frac{1}{2}$″; *weight*, 4 lbs. Shape the same as the former, but smaller in dimensions; horizontal edge of the one arm, $\frac{7}{8}$″; largest section of lens-shaped eye, 1$\frac{3}{4}$″ × 2$\frac{3}{4}$″.

11,252 (3) SINKING SHOVEL (Plate V., fig. 6). Shield-shaped steel blade (double), 12″ long, 10″ broad, and short-pointed, side edges turned gradually up from centre; upper edge at right-angle to axis; *helve*, 1$\frac{1}{4}$″ diameter × 2′ 2″ length, with half-circular eye; it is slightly curved downwards near junction with blade, and set to the socket-shaped and split shoulder at an angle of 150°. *Weight*, 4 lbs.

11,253 (4) DRIVING PICK (Plate V., fig. 3), one-armed. *Head*, 12″ × 3″; *handle*, 2′ 2″, anchored with iron key; *poll*, $\frac{5}{4}$″ × 1″, 2″ long, and bevelled; *eye*, 2$\frac{1}{2}$″ × $\frac{7}{8}$″, elliptic; *section*, $\frac{3}{4}$″ × 1$\frac{1}{8}$″, 2″ beyond centre; *weight*, 4 lbs. The arm, which is bent slightly downwards, tapers regularly from the lozenge-shaped centre-block to a $\frac{5}{16}$″ horizontal edge.

11,254 (5) DRIVING PICK, one-armed, and larger than the former. *Head*, 14$\frac{1}{2}$″ × 3″; *handle*, 2′ 4″; *eye*, 2$\frac{3}{4}$″ × $\frac{7}{8}$″; *section*, $\frac{5}{8}$″ × $\frac{7}{8}$″, 2″ beyond centre; *poll*, 2″ long × 1$\frac{1}{8}$″ square; *weight*, 5 lbs. The arm is slightly bent, leaving the under-side nearly straight, and tapers from a lozenge-shaped centre-block regularly to a $\frac{3}{8}$″ horizontal edge.

11,258 (9) PADDOCKING SHOVEL (Plate V., figs. 5 and 6*b*), used in forming paddocks and other earthworks on the surface. *Handle*, 4′ long × $\frac{5}{4}$″ diameter; *weight*, 5 lbs.; *steel blade*, 12″ high × 10″ upper edge. The double steel blade is short pointed, with its sides regularly curved upwards; the helve is fixed in the same manner and at the same angle (150°) as the one of the small shovel, No. 11,252, and also slightly curved downwards near the junction with blade.

Museum No.

11,257 DIPPER (Plate V., fig. 7). A frustrum-shaped, shallow tin vessel,
(8) provided with a long handle for feeding the cradle with water; this is often done by the same man who rocks the cradle. *Handle*, 4′ 9″ long × $\frac{7}{8}$″ diameter, fixed at an angle of 24° to a conical socket, going through the vessel, the size of which is 9″ upper diameter, $5\frac{1}{2}$″ bottom diameter × 4″ depth; *weight*, $3\frac{1}{4}$ lbs.

11,256 PROSPECTING TIN DISH or WASHING-PAN (Plate V., fig. 8).
(7) Used for testing by washing alluvial gold-bearing soil, obtained either directly from the ground or out of the cradle. The sand, clay, and other earthy particles are removed by a peculiar careful motion of washing, leaving the gold in the hollow angle, according to its specific gravity. *Weight*, $2\frac{1}{2}$ lbs.; *size*, $17\frac{1}{2}$″ diameter × 11″ bottom diameter × $3\frac{1}{2}$″ depth.

11,255 RIDDLE (Plate V., fig. 9). Used to strain the washing stuff by dipping
(6) the filled riddle into the washing-pan, placed underneath and filled with water, in order to get rid of the coarser portions of the debris, prior to washing off, and to save time and fine gold. *Size*, 13″ upper diameter × 9″ bottom diameter × 3″ depth; *weight*, 1 lb.; *number and size of holes in bottom*, 53 holes, $\frac{3}{16}$″ diameter.

IMPLEMENTS USED FOR QUARTZ MINING IN VICTORIA.

(Museum Nos. 11,240–49, Plate IV., Figures 7 to 14, and Plate V., Figure 1.)

Museum No.

11,240 SINKING POLL PICK (Plate IV., fig. 10), single-armed and pointed.
(1) *Head*, 11″ and 4″ long, slightly bent; *handle*, 27″ long, elliptic; *poll*, $2\frac{1}{2}$″ long × $\frac{5}{4}$″, square face, bevelled; *eye*, $2\frac{1}{4}$″ × $\frac{7}{8}$″, elliptic; *section of arm*, $\frac{5}{4}$″ square, 2″ beyond centre, tapering regularly to a point; *weight*, 6 lbs.

11,241 SINKING PICK (Plate V., fig. 1), single-armed and pointed. *Head*,
(2) 11″ and 4″ long; *handle*, 26″ long; *poll*, $2\frac{1}{2}$″ long × $\frac{5}{4}$″, square face, bevelled; *eye*, $\frac{5}{8}$″ × 2″, elliptic; *central section*, $\frac{5}{4}$″ square, tapering gradually towards point; *weight*, 5 lbs.

11,242–43 GADZES. 7″ long; *striking head* suddenly contracted from main section,
(3 and 4) $1\frac{1}{8}$″ × $\frac{3}{4}$″, by a height of $\frac{5}{4}$″; pointed end gradually tapering from centre; *weight*, $1\frac{1}{2}$ lbs. each.

Museum No.

11,244 (5) BORING HAMMER (Plate IV., fig. 7), single-hand, all edges bevelled. *Head,* $5\frac{1}{2}''$ long; *handle,* $11\frac{1}{2}''$ long; *centre section,* $2\frac{1}{4}'' \times 2''$; *eye,* $\frac{3}{4}'' \times \frac{5}{4}''$; *faces,* $2\frac{1}{4}'' \times 1\frac{3}{4}''$; *weight,* $5\frac{1}{2}$ lbs.

11,245 (6) SLEDGE HAMMER (Plate IV., fig. 9), octagonal between centre and faces. *Head,* $6\frac{1}{2}''$ long; *handle,* 2′ 5″ long; *centre section,* $2\frac{1}{2}''$ square; *eye,* $1'' \times 1\frac{1}{2}''$; *faces,* 2″ diameter; *weight,* $9\frac{1}{2}$ lbs.

11,246 (7) LONG JUMPER or Double-hand Borer (Plate IV., fig. 14). *Length,* 7′ 3″; *diameter,* 1″; *cutting edge,* $1\frac{3}{8}''$ wide, curved, and on both ends; *weight,* 19 lbs.

11,247 (8) DRILL (Plate IV., fig. 13), double-hand. 2′ 2″ long; 1″ diameter; *cutting edge,* $1\frac{1}{2}''$ wide; *weight,* 6 lbs.

The edges of both drills are formed by two narrow planes, meeting at an angle of 78°.

11,248 (9) IRON BUCKET and SAFETY-HOOK (Plate IV., fig. 11). *Diameter of bucket,* 11″; *depth,* 15″; *sheet iron,* $\frac{3}{64}''$–$\frac{1}{16}''$; *weight of bucket,* $11\frac{3}{4}$ lbs.; *weight of hook,* $1\frac{1}{2}$ lbs. The bucket is generally made of a strong oil-can; the handle of $\frac{1}{2}''$ round iron, hinged to nooses, which are rivetted below a strong ring around the rim of the bucket. The safety-hook, called ear-hook, is made of $\frac{1}{2}''$ round iron, and bent and connected with the chain and bucket, as seen in the figure. It is only very rarely, by some extraordinary accident, that this hook ever becomes disengaged from the noose on the handle of the bucket when the latter is suspended; while, on the other hand, the bucket can be easily taken off without delay, either on the top or at the bottom of the shaft, for tilting or filling. The content of the bucket is $1\frac{1}{2}$ cubic feet, holding about 80–90 lbs. of broken stone.

BICKFORD'S PATENT SAFETY FUSE, three coils of different samples of, viz.:—

11,249 (10) Patent Safety Fuse for *dry* blastings especially.

22,263 (11) Patent Single Tape Fuse, for *wet* blastings. No. 8.

22,264 (12) Patent Double Tape Fuse, for blasting *under water.* No. 9.

All of these are generally sold in coils of 25 feet each, and at an approximate price of 6s. per dozen coils in Melbourne. The invention of the Safety Fuse, which was originally in a round form (*see* 10), was patented in 1831 by Mr. W. Bickford, of Tucking Mill, Cornwall. It consists of an inner hempen tube enclosing a cylinder of gunpowder, and afterwards overlaid by a second weft, which is saturated with a waterproof material, and finally varnished to preserve the contents from injury by wet or adhesion to the tamping or to the rock. The other samples are modifications of the original form, but especially prepared for use in wet situations, or entirely under water. (11 and 12). The adoption of the safety fuse for

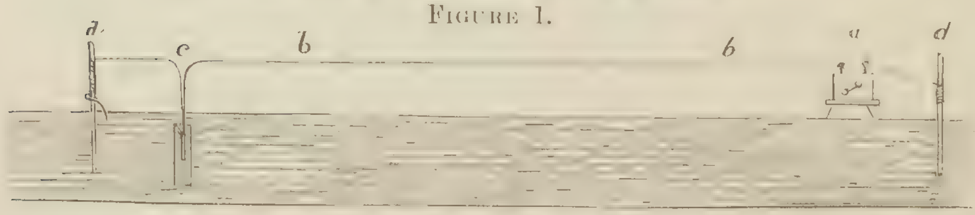
Museum No.

rock blasting operations has almost entirely superseded the old and dangerous system of blasting by loading and firing with the needle and touchpaper. The safety fuse, after having been straightened and inserted into the powder-charge for one inch or more, is first fixed by the wadding, and afterwards rammed up with the tamping against the side and to nearly the brim of the hole, leaving, however, in all cases, a good length of it projecting beyond the mouth of the hole, for the purpose of lighting, which is usually done by placing a burning piece of candle underneath it near the end, allowing thus time for the men to escape before the closely woven tube of the fuse is burned through. In wet blasting operations the second, and especially the third kind of flat fuse, are quite as effective as when employed in dry situations. If the charge is placed in a waterproof bag, to which a sufficient length of fuse is tightly attached, and the whole rammed cautiously down, neither the powder in the bag-cartridge, nor that in the fuse, will become wet. In the old way of loading a wet hole, it was extremely difficult, and in some cases impossible, to prevent the charge and train from becoming damaged. Besides Bickford's Patent Fuses, which were hitherto almost the only ones employed in the Victorian mines, etc., there are of late several other kinds in use, such as the colonial fuse called "Whitehorn's Patent Blasting Fuse," of continuous length (22,265).

22,266–67 ABEL'S PATENT ELECTRIC FUSES for Blasting or for Artillery. (Presented by R. L. J. Ellery, Esq., Government Astronomer.)

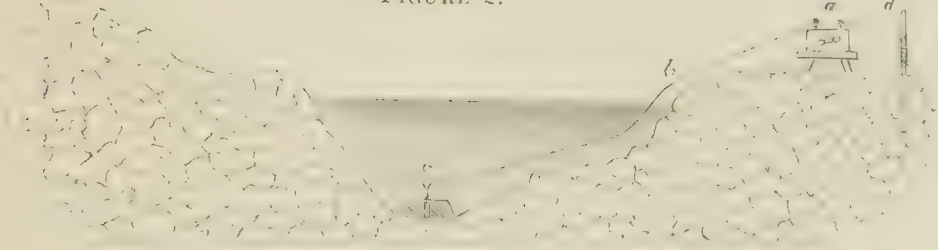
These are fuses to be used with a small portable magneto-electric apparatus known as "Wheatstone's Exploder." If employed for blasting, the fuse is inserted into a blasting charge. One of the insulated wires is connected with an insulated conducting wire leading to one pole of the exploder; the other insulated wire (if it is a blast on shore) is attached to some earth-connection, such as an iron bar thrust into the ground until it reaches moist earth. A turn of the exploder fires the charge from almost any distance. Any number of charges can be fired simultaneously. The accompanying diagrams, figures 1 and 2, show respectively the arrangements for firing charges in *dry overground* and *under water*:—

FIGURE 1.



Overground.—*a*, exploder; *b*, insulated conducting wire; *c*, blast charge and fuse; *d d*, earth-connections.

FIGURE 2.



Under water.—*c*, subaqueous charge with fuse; *d*, end of one of the fuse-wires exposed to the water; *b*, conducting wire; *a*, exploder

SET OF ENGLISH DRAINING TOOLS FOR CUTTING NARROW AND DEEP DRAINS.

(Museum Nos. 17,973–78.)

		Blade (trapezoidal).			*Helve (straight)*				
Museum No.		Height.	Upper edge.	Cutting edge.	Length.	Angle to blade.	Section.		Weight.
17,973	Set of Five	13″	$6\frac{3}{4}$″	5″	2′ $4\frac{1}{2}$″	15°	$1\frac{1}{2}$″	Stirrup handle	6 lb.
17,974	DRAINING	15″	$6\frac{3}{4}$″	4″	2′ 7″	15°	$1\frac{1}{2}$″		7 lb.
17,975	SPADES	20″	$6\frac{1}{4}$″	4″	2′ 4″	15°	$1\frac{1}{2}$	T handle	8 lb.
17,976	of different	18	$6\frac{1}{4}$″	$3\frac{3}{4}$	2′ 1″	15°	$1\frac{1}{2}$″	Stirrup handle	$6\frac{1}{2}$ lb.
17,977	dimensions.	17″	$5\frac{3}{4}$″	$3\frac{1}{2}$″	2′ 4″	15	$1\frac{1}{2}$″		$6\frac{3}{4}$ lb.

In all the above spades the helve is fixed in the usual way by rivets to a long split socket, running out from the body of the blade; the side edges are slightly but regularly curved upwards.

17,978 DRAW-EARTH DRAIN SCOOP. *Helve*, 6′ 4″ long × $\frac{7}{4}$″ diameter; *scoop*, semicircular by 3″ diameter and 14″ length, round neck = $\frac{1}{2}$″ diameter; *angle* (between scoop and helve), = 55°; *weight*, $5\frac{1}{2}$ lbs. This scoop is used to remove from the bottom of the finished drain the accumulated sludgy matter before the sole-tiles or sods, etc., are laid down. It consists of a semicircular (often quadrangular) trough of iron, and is of a size corresponding with the bottom of the drain. The helve, which is long enough to reach the bottom of the drain, while the laborer stands across it, is fixed with rivets to a 13″ long socket, partly split open.

SET OF TOOLS USED IN ENGLISH COLLIERIES.

(Museum Nos. 17,956–71. Plate III., Figures 10 to 16, and Plate IV., Figures 1 to 6.)

Museum No.

17,956 STONE PICK (Plate IV., fig. 3), two-armed and slender pointed (Cutting Mandril). *Head*, 25″ long, anchored by $2\frac{1}{2}''$ height, arms tapered regularly from centre to the points; *handle*, 2′ 6″, drawn in on both sides to elliptic section = $1\frac{7}{8}'' \times 1\frac{1}{8}''$ about $5\frac{1}{2}''$ from head, (cross-wedged); *eye*, $1\frac{1}{4}'' \times 4''$, elliptical; *eyeblock* swelled to $1\frac{3}{4}''$ width across centre on top, drawn out to short and tapered V-cheeks; *section of arms*, $1\frac{1}{4}'' \times 1''$ about $2\frac{1}{4}''$ beyond centre; *weight*, $5\frac{1}{2}$ lbs. (without handle).

17,957 COAL PICK (Plate IV., fig. 2), two-armed (Cutting Mandril). *Head*, 20″, anchored by $1\frac{3}{4}''$ height, arms diminishing regularly from centre to slender points; *handle*, 2′ 6″, drawn in on both sides to $1\frac{3}{4}'' \times \frac{7}{8}''$ about 5″ from head (cross wedged); *eye*, $3'' \times \frac{7}{8}''$, lens-shaped; *eye-block* swelled to $1\frac{3}{8}''$ width, V-cheeked; *section of arms*, $\frac{7}{8}''$ wide $\times \frac{3}{4}''$ high, about 2″ beyond centre; *weight*, $3\frac{1}{4}$ lbs.

17,958 59 COAL PICKS (Plate IV., fig. 1), two-armed (Holing Mandrils). *Head*, $19\frac{1}{2}''$ long, upper face nearly horizontal; lower and side faces tapering regularly from centre to the points; *handle*, 2′ 6″, drawn in to $1\frac{3}{8}'' \times \frac{7}{8}''$ ellipt. section about 4″ from head (cross-wedged); *eye*, $3'' \times \frac{7}{8}''$, lens-shaped; *eyeblock*, as No. 17,957: *section of arms*, as No. 17,957; *weight*, 3 lbs.

17,960 COAL SLEDGE WEDGING-HAMMER (Plate IV., fig. 9). *Head*, 11″ long, chamfered and shaped round at both ends; *handle*, 2′ 3″ long; *faces*, $1\frac{3}{8}''$ diameter (flat); *eye*, $\frac{7}{8}'' \times 1\frac{1}{2}''$; *vertical sections*—across eye, $1\frac{3}{4}'' \times 2\frac{1}{8}''$; $1\frac{1}{2}''$ beyond centre, $2'' \times 1\frac{3}{8}''$; *weight*, $7\frac{1}{2}$ lbs.

17,961 DOUBLE-HAND BORING-HAMMER (Plate III., fig. 11). *Head*, 8″ long, strongly stop-chamfered; octagonal section shaped round at both ends; *handle*, 2′ 3″; *faces*, 2″ diameter (flat); *eye*, $\frac{13}{16}'' \times 1\frac{5}{8}''$; *vertical section*, 2″ square; *weight*, 8 lbs.

17,962 TAMPING-HAMMER (Plate III., fig. 10). *Head*, 8″ long anchored by $\frac{1}{2}''$ height; edges bevelled; *handle*, 12″; *faces*, $1\frac{1}{4}''$ diameter (flat); *eye*, $\frac{5}{8}'' \times 1\frac{1}{4}''$; *vertical sections*—across eye, $1\frac{1}{2}'' \times 1\frac{1}{4}''$; beyond centre, $\frac{5}{4}''$ square; *weight*, $3\frac{1}{2}$ lbs.

Museum No.

17,963–64 COAL MINING GADS (Plate III., fig. 12). *Length*, $9\frac{1}{2}'$; *base, or greatest section*, $1\frac{3}{8}'' \times \frac{3}{4}''$ about 5″ from striking point, quadrangular and tapering regularly to a point; *striking point* formed by a short, bluff frustra of an irregular octagonal section = $1'' \times 1\frac{1}{8}''$: *weight*, 3 lbs.

17,965 COAL DRILL (Plate III., fig. 16). *Length*, 3′ 9″; *section*, $\frac{9}{16}''$ (square); *cutting edge*, curved, thin, and chisel-shaped, $\frac{5}{4}''$ long, angle = 75°; *weight*, 5 lbs.

17,966 COAL DRILL (Plate III., fig. 15). *Length*, 4′; *section*, $\frac{9}{16}''$ (square): *cutting edge*, curved, thin, and chisel-shaped, $\frac{5}{4}'$ long, angle = 75°: *weight*, 6 lbs.

17,970 STONE DRILL (Plate III., fig. 14). *Length*, 3′ 3″; *section*, $\frac{7}{8}''$ (octagonal); *cutting edge*, $1\frac{3}{8}''$ long, strongly curved: curved faces at angle = 75°: *weight*, $7\frac{1}{2}$ lbs.

17,967 COAL SCRAPER (Plate IV., fig. 6). *Shaft*, 3′ 8″ long, $\frac{5}{8}''$ diameter, both ends provided with scrapers, placed on opposite sides; *shoe or scraper*, circular, by 1″ diameter and set at an obtuse angle: *weight*, 2 lbs.

17,968 BLASTING PRICKER (Plate III., fig. 13), for blasting coal. Total *length*, 3′ 9″; *poll-head*, 5″ long × $\frac{7}{8}''$, octagonal section flattened out to an eyeblock $\frac{3}{8}''$ thick by $1\frac{1}{2}''$ width, which is pierced by a $\frac{3}{4}''$ hole for inserting a handle or key-bar; *greatest section of needle*, $\frac{1}{2}''$ diameter, tapering to $\frac{1}{4}''$ diameter, by 3′ 2′ length; *weight*, 3 lbs.

17,969 TAMPING-BAR of Iron (Plate IV., fig. 5). *Length*, 3′ 6″: *section of shaft*, $\frac{5}{8}''$ diameter; *head*, short and bluff, with elliptic face $\frac{7}{8}'' \times \frac{3}{4}'$ and straight with shaft at back of groove; *groove*, 3″ high, wide and shallow, projecting beyond shaft: *weight*, 4 lbs.

17,971 CORNISH SWABBING STICK (Plate IV., fig. 4). *Length*, 4′ 3″ by $\frac{7}{8}''$ diameter throughout: made of hardwood.

SET OF CORNISH BLASTING AND OTHER MINING TOOLS.

(Museum Nos. 17,936–47. Plate III., Figures 1–9.)

Museum No.

17,936 CORNISH DRILL (Plate III., fig. 8). *Length*, 16″; *section*, $\frac{7}{8}$″ (octagonal); *edge*, $1\frac{3}{8}$ (curved): *weight*, 3 lbs.: *angle of edge* = 65° (curved planes).

17,937 CORNISH DRILL (Plate III., fig. 8). *Length*, 20″; *section*, $\frac{7}{8}$ (octagonal); *weight*, $3\frac{1}{2}$ lbs.: *angle of edge* = 65° (curved planes).

17,938 CORNISH DRILL (Plate III., fig. 8). *Length*, 2′ 3″; *section*, $\frac{7}{8}$″ (octagonal); *weight*, 6 lbs.; *angle of edge* = 65° (curved planes).

17,939 JUMPER (Plate III., fig. 6). *Length*, 3′ 3″; *section*, $\frac{7}{8}$″ diameter: *edge*, $1\frac{3}{4}$″ (curved); *weight*, $11\frac{1}{2}$ lbs.; *angle of narrow edge-planes* = 87°.

17,940 IRON SCRAPER (Plate III., fig. 7). *Length*, 3′; *weight*, $1\frac{1}{2}$ lbs. One end provided with a flat 1″ circular shoe, and the other with a 5 to 6″ long 1″ shell auger.

17,941 TAMPING-BAR (Plate III., fig. 9). *Length*, 2′ 6″; *diameter*, $\frac{3}{4}$″: *face*, 1″ diameter; *weight*, 4 lbs.

17,942 IRON MALLET (Sledge) or Double-hand Boring-Hammer. (Plate III., fig. 3). *Head*, $4\frac{1}{2}$″; *handle*, 25″: *centre-section*, 3″ × 2″: *striking-face*, abruptly drawn in to 1″ diameter: *eye*, $2\frac{1}{4}$″ × $1\frac{1}{8}$: *weight*, $5\frac{1}{2}$ lbs.

17,943-4 TWO GADS (Plate III., fig. 5). Each 6″ long, and weighing $\frac{3}{4}$ lb.: *main section*, 1″ × $\frac{3}{8}$″.

17,945 CORNISH POLL PICK (Plate III., fig. 1), single armed. Arm gradually tapering to a point, and slightly bent so as to make an angle of 70° with its handle. *Head*, 14″ and 3″; *poll*, 2″ long × $1\frac{1}{8}$ square (bevelled); *handle*, 2′ 2″; *eye*, $\frac{7}{8}$″ × 2″; *vertical eye-section* = $2\frac{1}{3}$″ × $1\frac{1}{2}$″: *section*, $\frac{3}{4}$″ × $\frac{3}{4}$″, 3″ beyond centre: *weight*, 5 lbs.

17,946 CORNISH BUCKER (Plate III., fig. 4). Used for Dressing Ores. *Striking-plate*, 4″ × 5″ × $\frac{3}{4}$″ thickness; *handle*, 13″ long; *weight*, 6 lbs. The eye into which the short handle is fixed by a wooden wedge is formed by a strong broad staple, $1\frac{1}{2}$″ × $3\frac{1}{2}$″, welded to the plate at right angles.

17,947 COBBING-HAMMER (Plate III., fig. 2). Ore-dressing tool, double-faced. *Head*, 14″ (7″ and 7″); *handle*, $7\frac{1}{2}$″: *eye*, $\frac{3}{8}$″ × 1″: *faces*, $\frac{3}{8}$″ wide × $1\frac{3}{4}$″ high; *weight*, $4\frac{1}{4}$ lbs. The arms are curved, and the faces parallel to the axis of the handle. *Vertical section across centre*, = $1\frac{3}{4}$″; *vertical section* 2″ *beyond centre*, = $\frac{7}{8}$″ × $1\frac{1}{2}$″.

SET OF BLASTING AND OTHER MINING TOOLS AS USED IN THE HARZ, GERMANY.

(Museum Nos. 11,289–316. Plate I., Figures 1 to 13; and Plate II., Figures 1 to 14.)

(*a.*)—TOOLS FOR DRILLING HOLES BY TWO MEN (ZWEI MÄNNISCHES GEZÄHE OF THE GERMAN MINERS.)

Museum No.

11,289 (27) CROWN DRILL (Kolbenbohrer). Plate II., fig. 4. *Length*, 2′ 8″; *section of shaft*, $\frac{7}{8}$″ square; *weight*, $6\frac{1}{2}$ lbs.; *length of cutting edge*, $1\frac{1}{8}$″ square, and cross-edged; *angle of edge planes*, 90° (triangular-curved).

Museum No.		Length.	Section of shaft.	Weight.	Length of cutting edge.	Angle of edge planes.
11,290	Three JUMPERS or DRILLS (Meisselbohrer). Plate II., figs. 1–3.	2′ 3″	$\frac{7}{8}$″ square (bevelled)	6 lbs.	$1\frac{3}{8}$″	85° (Planes = [illegible] broad)
11,291		3′ 0″		8 lbs.	$1\frac{1}{4}$″	
11,292		3′ 6″		10 lbs.	$1\frac{3}{8}$″	
(28–30)						

11,293 (31) SCRAPER (Krätzer). Plate II., fig. 6. *Length*, 3′ 0″; *section of shaft*, $\frac{3}{16}$″ × $\frac{7}{16}$″; *weight*, 1 lb.

11,295 (33) IRON RAMMING or TAMPING BAR (Stampfer, Ladestock). Plate II., fig. 5. *Length*, 3′ 1″; *section of shaft*, $\frac{7}{8}$″ diameter (grooved for the reception of needle); *weight*, 7 lbs.; *elliptical head*, 1″ × $1\frac{1}{4}$″.

11,294 (32) IRON NEEDLE (Schiess-nadel) made of Wrought Iron. Plate II., fig. 7. *Length*, 3″; *greatest diameter* = $\frac{5}{16}$″, diminishing gradually to a point; *handle*, ring-shaped and flat; *weight*, = 1 lb. The iron needle (which, to prevent ignition by the striking of iron against quartzose substance in the tamping, is frequently replaced by one made of copper) is used to form a passage between the mouth of the bore-hole and the charge within through the tamping; the needle, after being inserted about 1″ into the powder cartridge, is rammed in cautiously against the wall of the bore-hole, and afterwards withdrawn for the introduction of the fuse (Schwefelmännchen), described under No. 11,284.

11,307 (45) DOUBLE-HAND HAMMER (Zweimännisches Fäustel). Plate I., fig. 12. *Length of head*, 8″ (slightly curved); *length of handle*, 2′ 2″; *striking face*, $\frac{3}{4}$″ square (bevelled); *weight*, 6 lbs.

(*b.*)—TOOLS FOR DRILLING HOLES BY ONE MAN (EINMÄNNISCHES GEZÄHE OF THE GERMAN MINERS).

Museum No.

11,296 (34) CROWN DRILL (Kolbenbohrer). Plate II., fig. 9. *Length*, 2′; *section of shaft*, $\frac{11}{16}''$ square; *weight*, $3\frac{1}{4}$ lbs.; *length and shape of cutting edge*, head = $\frac{7}{8}''$ square (cross-edge): *angle of edge-planes*, triangular planes at 90°.

Museum No.		Length.	Section of shaft.	Weight	Length and shape of cutting edge		Angle of edge planes.
11,297	Three DRILLS	1′ 10″	$\frac{5}{8}''$	3 lbs.	$1\frac{7}{16}''$	$\frac{7}{16}''$ broad, and slightly curved	All at 80°
11,298	(Bergbohrers)	2′ 2″	square	$3\frac{1}{2}$ lbs.	$1\frac{5}{16}''$		
11,299	Plate II., figs.	2′ 6″	(bevelled)	4 lbs.	$1\frac{3}{16}''$		
(35–37)	11 to 13						

11,300 (38) IRON NEEDLE (Plate II., fig. 8). Similar in shape to the preceding one, but stronger; made of wrought iron. *Length*, 2′ 6″; *greatest diameter*, $\frac{1}{4}''$; *weight*, $\frac{3}{4}$ lb.

11,301 (39) IRON RAMMING or TAMPING BAR (Plate II., fig. 24). *Length*, 2′ 4″; *shaft*, $\frac{5}{8}''$ diameter (with semicircular groove); *weight*, $3\frac{1}{2}$ lbs.; *head* (elliptical), $\frac{7}{8}'' \times \frac{3}{4}''$.

11,308 (46) SINGLE-HAND HAMMER (Einmännisches Fäustel, of the German miners). Plate I., fig. 8. *Length of head*, 7″ (curved); *eye*, $\frac{11}{16}'' \times \frac{5}{8}''$; *length of handle*, 11″; *striking face*, $1\frac{1}{8}''$ square (edges broken); *weight*, $3\frac{1}{2}$ lbs.

Museum No.		Length of head.	Length of handle.	Eye.	Striking faces.	Weight.
11,309	TWO DRESSING-HAMMERS (Erzfäustel).	$6\frac{1}{2}''$	$10\frac{1}{2}''$	$\frac{5}{4}'' \times \frac{5}{4}''$	$1\frac{1}{2}''$ square, and $1\frac{1}{2}'' \times 1''$ in each (vertical)	2 lbs.
11,310 (47–48)	Plate I., fig. 9 and 11.	$7\frac{1}{2}''$ (straight-armed)	$10\frac{1}{2}''$	$1\frac{3}{8}'' \times \frac{5}{8}''$		3 lbs.

11,302 (40) DRESSING-HAMMER (Scheidehammer). Plate I., fig. 6. *Length of head*, 8″ (straight); *eye*, = $\frac{7}{8}''$ diameter; *length of handle*, 2′ 2″ × $\frac{7}{8}''$ diameter; *striking face*, $1\frac{1}{8}''$ square (edges broken); *weight*, 4 lbs.

11,303 (41) SLEDGE-HAMMER (Treibe or Gang-fäustel). Plate I., fig. 7. *Length of head*, $6\frac{1}{2}''$, strongly bevelled; *length of handle*, 25″ × $\frac{5}{4}''$ diameter; *face or edge*, $2\frac{1}{2}''$ square; *weight*, 12 lbs.

11,311 (49) GAD (Bergeisen). Plate I., fig. 10. *Cross-section* (vertical), $1\frac{1}{4}''$; *length*, 6″; *handle*, 11″; *eye*, $\frac{7}{8}'' \times \frac{7}{16}''$, (central); *striking face*, $\frac{7}{8}''$ square, on a $2\frac{1}{2}''$ long poll-end; *weight*, $1\frac{1}{4}$ lbs. The pointed end tapers regularly from centre and ends into a short pyramid $\frac{1}{2}''$ high. This gad resembles a slender hammer, when in use, for trimming the

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face of a wall, &c , a handle being then put into the rectangular eye in the centre of the head, and held by one hand while the gad is driven by striking on the poll end.

11,304 (42) WEDGE (Timmel). Plate I., fig. 13. *Length*, 13″ : *striking head*, 2″ square, bevelled edges; *point* formed by tapering gradually, about 3″ from striking face : *weight*, $9\frac{1}{2}$ lbs.

11,305 (43) MINING PICK (Spitz or Schräm-Hammer), one-armed, with poll end. (Plate I., fig. 1.) *Head*, 10″ by 4′ : *handle*, 26″ ; *eye*, = $\frac{7}{8}$″ × $1\frac{7}{8}$″: *poll*, 3″ long by $1\frac{1}{8}$″ square ; *weight*, $5\frac{3}{4}$ lbs. Arm tapering from centre to a $\frac{1}{4}$″ horizontal edge.

11,315 (53) AXE (Bergaxt, Kaukamm). Plate I., fig. 3. *Head*, 7″ × $2\frac{1}{2}$″ : *handle*, 26″; *eye*, = 1″ × $2\frac{1}{2}$″, wedge-shaped; *poll*, $1\frac{1}{2}$″ × $3\frac{1}{2}$″. short and steeled : *edge*, $3\frac{1}{2}$″ high : *weight*, $5\frac{1}{2}$ lbs.

11,313 (51) CROWBAR (Brechstange). Plate II., fig. 14. *Length*, 4′ 6″: *weight*, 20 lbs.; *edge of shoe*, $1\frac{3}{8}$″: *edge of chisel*, $\frac{3}{4}$″. The largest section of shaft, the edges of which are bevelled, = [illegible]″ square, tapering regularly down to 1″ square, about 4″ from a $\frac{3}{4}$″ chisel end ; the other end is provided with a shoe, $3\frac{1}{2}$″ high and projecting at a right angle to an extent of 1″ from one side of the thickest shaft-end, shaping then under an acute angle straight into a $1\frac{3}{8}$″ edge.

11,312 (50) PAIR OF FORCEPS (Bohrzange or Kluppe). Plate II., fig. 10. *Length*, 3′, when drawn in ; *weight*, 3 lbs.: *section of arms*, $\frac{3}{8}$″ diam. Used for clearing a borehole from fragments of metal, stone, &c. It consists of two arms of round iron, one of which, provided at one end with a pair of flat spring-pincers, $\frac{5}{8}$″ broad and $4\frac{1}{2}$″ to 5″ long, is made to slide through two staples, placed at right angles and 2′ 3″ apart, on the other arm to a height of 4 inches. When the arm with the pincer-head is pushed down the given full stroke, the pincer opens about 2″, but can be drawn up at pleasure to secure an object within. The handle of each arm is formed by a scroll like the handle of a scissors.

11,314 (52) CROSSCUT SAW (Berg-Säge). Plate I., fig. 5. *Length*, 4′, curved : *teeth*, $\frac{5}{16}$″ × $\frac{3}{8}$″ height; *height of blade*—middle, 6″. on each end, $1\frac{1}{2}$″. *Handles* of wood, round and fixed in the usual way through an eye at each end of the saw.

11,316 (54) TROUGH (Bergtrag or Mulde). Plate I., fig. 4. Used for carrying ores, &c., short distances. The trough is made of hardwood $\frac{3}{4}$″ thick throughout, and of a size 20″ × 12″ × 3″ depth, with rounded corners.

Museum No.

11,306 (44) IRON SCRAPER (Berg-Kratze). Plate I., fig. 2. *Blade*, trapeziform, $\frac{1}{4}''$ thick at the back; *head*, $7''$; *eye*, $2\frac{1}{2} \times 1\frac{1}{2}'$; *handle*, $2'\ 3''$, set to blade at an angle of 130°; *edge*, curved, $18'' \times 2\frac{1}{2}''$ wide, $\frac{3}{16}''$ thick. Underneath the handle, about the middle and at the end, a nose is attached for the support of the hands. Used as a filling-shovel.

SET OF BLASTING TOOLS AS USED IN THE IMPERIAL MINES OF SAXONY.

(Museum Nos. 11,259–83.)

Museum No.		Length.	Section.	Edge.	Weight.	Angle of edge planes.
11,272	(A.)—ONE SET OF SIX DRILLS (Bergbohrers). Plate II., figs. 18–23.	$13\frac{1}{2}''$	$\frac{9}{16}''$ square, and beveled	$1\frac{1}{8}''$ to $1\frac{1}{16}''$ wide, almost straight	$1\frac{1}{2}$ lbs.	70° to 85° curved
11,273		$19''$			2 lbs.	
11,274		$21\frac{1}{2}$			$2\frac{1}{8}$ lbs.	
11,275		$23''$			$2\frac{1}{4}$ lbs.	
11,276		$25''$			$2\frac{1}{2}$ lbs.	
11,277		$2'\ 6''$			3 lbs.	

11,278 (C.) SMALL CROWBAR (Schräm-spiess). Plate II., fig. 25. *Length*, 2; *section*, $\frac{9}{16}''$ square; *edge*, $\frac{5}{16}''$ wide; *weight*, $3\frac{1}{4}$ lbs. Used for breaking into the face of a wall, &c., or removing blocks of rock, &c., loosened by the blast and natural fissures. The shaft is bevelled and one end is provided with a chisel face, having a $\frac{5}{16}'$ edge.

11,280 (E.) WOODEN RAMMER or Tamping-Rod. *Length*, $22''$; *section*, $\frac{11}{16}'$; *face*, $\frac{5}{8}''$ diam. The shaft is provided with a semicircular $\frac{3}{8}''$ groove.

11,279 (D.) IRON TAMPING-BAR (Stampfer or Ladestock). Plate II., fig. 24. *Length*, $2'\ 1$; *section*, $\frac{5}{8}''$ diam.; *face*, $\frac{5}{8}''$ diam., approaching ellipse: *weight*, $2\frac{1}{2}$ lbs.; *groove on shaft*, semicircular, 15 18″ long, $\frac{3}{16}''$ diam.

11,281 (F.) IRON SCRAPER (Krätzer). Plate II., fig. 6. *Length*, $2'\ 4'$ (of flat iron); *weight*, $\frac{3}{4}$ lb.; *head*, = $\frac{3}{4}'$ diam., at the other end an eye or loop.

11,282 (G.) BLASTING NEEDLE of Wrought Iron (Schiess-nadel). Plate II., fig. 8. *Length*, $2'\ 2''$; *largest diameter*, $\frac{1}{4}''$; *weight*, = $\frac{5}{8}$ lbs.; ring-shaped, flat handle.

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11,283 (L.) IRON LEVER (Plate II., fig. 16). *Handle-arm*, 2′ 4″ long: *lever-arms*, - 2′ and 4″ (round); *hole*, for inserting the drill, $\frac{3}{4}$″ diameter; *weight*, = $5\frac{1}{2}$ lbs. Used principally to lift a drill or other tool, which sticks fast in the hole: also for guiding a drill.

11,271 (B.) SINGLE-HAND HAMMER (Berg-fäustel). Plate II., fig. 17. *Handle*, $11\frac{1}{2}$″; *head*, $4\frac{1}{2}$″ (steeled and bevelled), straight armed; *faces*, $1\frac{3}{8}$″ square; *weight*, 2 lbs.: *eye*, $\frac{3}{8}$″ × $1\frac{3}{8}$″.

11,259–70 (H.) SET OF TWELVE GADS (Bergeisen). Plate II., fig 15. Each 6″ long, slightly tapering to a point from middle section, $\frac{3}{4}$″ × $\frac{3}{8}$″: *weight*, 11lbs., including yoke; centre provided with an eye $\frac{7}{8}$″ × $\frac{7}{16}$″, for inserting a handle, as described in No. 11,311 (49). They are suspended on two rods, equally divided, in front of the breast of the miner, from an iron yoke across his shoulder, when going to or leaving his work, as represented on the sketch.

11,284 SECTION OF A CHARGED BOREHOLE (Besetztes Bohrloch). Plate VII., fig. 7.

The model represents a face of rock, containing a section of a borehole, loaded by the needle, 1″ wide and about 18″ deep, showing the proportions of the different parts constituting its charge, and the mode of firing the hole, as adopted in the mining districts of Saxony and the Harz.

a — *Powder-charge*, 7 inches high.

b — *Tamping*, or charge of prepared earth, &c. (Besatz).

b′ — *Passage*, left by the withdrawal of the needle, through the tamping, from the mouth of the hole down to the surface of the powder-charge.

c — *Sulphur-fuse* (Schwefel-männchen), consisting of powdered paper rolled up into a slender cone about 3″ long, with a sulphur-thread (*d*) attached to its base. It is stuck with its pointed end into the hole left by the needle (*G*), leaving only the greater part of the sulphur-thread outside. This is of sufficient length to ensure, when lighted, a slow and safe discharge of the blast.

The Plate VII., fig. 7, exhibits also sections of two boreholes, of which the one, 7*a*, represents a hole in course of being loaded, the charge consisting of a 7″ cartridge, over which the usual wadding is placed, while the rest of the hole is not yet rammed up with tamping, and consequently the needle (*B*) is not yet withdrawn. The other section, 7*b*, represents a borehole loaded with a loose powder-charge, the usual wad and tamping (*c*), and ready for being fired by means of touchpaper or sulphur-fuse (schwefel-männchen (*s*) inserted into the well-clayed mouth of the hole.

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11,284 (continued). The usual manner of loading and firing the boreholes, as described, is as follows:—

After the hole is properly dried by wiping it out, the powder is poured in until it is filled to the desired height above the bottom. In steeply inclined, or vertical holes, the powder will always easily fill up the bottom, without the assistance of a scraper, wooden rammer, or a scoop; but in holes which are either horizontal or inclined upwards, these tools must be used.

Cartridges are generally used in wet holes, and in those inclining upwards. The powder-charge being inserted, the needle (*see* Plate II., fig. 7) is then introduced, entering the powder several inches, and kept in a central position with the hole, after which the wadding, consisting either of coarse sawdust, dry grass, or fine straw, and sometimes of a cylindrical piece of pine wood, is placed over it; and subsequently the tamping, composed either of fine fragments of stone free of any quartzose substance, or burnt clay (broken bricks), is successively rammed down around the needle by means of an iron rammer or tamping-bar. The needle is frequently turned, and slightly lifted, in order to prevent it from becoming fixed in the hole; the top of the hole is rammed up with damp clay. Thus loaded, the needle is carefully withdrawn, and the long, narrow passage left by the needle filled with fine powder; the touchpaper or sulphur-fuse (consisting sometimes of two or three powdered paper cones stuck one into another) is then inserted into the mouth of the hole, and the projecting sulphur-thread, or any other kind of slow match, after being properly fixed and adjusted, cautiously lighted; this slowly burns down, leaving sufficient time for the men to retreat before the fire is communicated to the powder charge. This old method of loading and firing a borehole, being uncertain in its effects, wasteful, and highly dangerous, is now being gradually superseded by the more simple, safe, and expeditious mode, by means of patent fuse, or commonly called "safety-fuse," described under the head of Victorian Implements for Quartz Mining (page 5, No. 11,249).

15,926 WORKING MODEL OF PORTABLE COMPRESSED AIR BORING APPARATUS (Schumann's Patent). Plates VI. and VII., figs. 1 to 6. Worked by compressed air, as used in the Freiberg Mining District, for boring in drives and adits of small dimensions. Scale of model = 1″ to 1′; Scale of wood-frame = 1½″ to 1′.

This apparatus is constructed on the same principle as the boring-machine used in the excavation of the great railway tunnel through Mt. Cenis, but it is simplified, and reduced in size, so as to allow of its being used in a narrow space, and of its being easily removed by one or two men.

The whole apparatus is placed with the pointed ends (J), of which one can be adjusted according to the unevenness of the rock face, in front of its frame (P) against the face of the drive, &c., in the direction of the hole

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15,926 continued. to be drilled, and secured in this position by working a screw-chuck (i, p) in at the back of the frame into a strong piece of timber (T), fixed purposely there, either upright or across the drive, &c. (*See* fig. 3, Plate VI.)

The admission of the compressed air, supplied by means of a vulcanized India-rubber hose from an apparatus placed either under or over ground, is through the neck or short pipe (B) on the top of the engine-chest (W). Having entered the latter, the course of the air is then divided to work simultaneously both the driving-piston (T) and the boring-piston (Z); the first through the slide valve (W), which is worked by an excentric in connexion with the crank-gear of that piston, and the second by passing through the channel (O) downwards into the valve-chest of the boring-cylinder, where the air is made to act, by means of a second slide valve (*e*), regulated by the engine-piston (T), alternately upon the front and back of the boring-piston, thus producing the percussive action. The air, after being used, escapes from the working cylinders through their respective "exhaust-ports."

The rotation of the drill is produced by a worm (H) on the crank-axle (Q) in gear with a small cam-wheel (L) on the boring-piston, within a box (R) in front of the cylinder (M). The piston (Z) being only connected with this wheel by stud and groove, is thus carried round without interrupting its back and forward motion, whilst the advance of the boring-apparatus is produced by a screw (u), which turns in a side-flange (U^1) of the boring-cylinder (M), and which is worked by a tooth (A) at the back end of the boring-piston (T). This tooth strikes during the revolutions of the piston against one of the four sharp-edged arms of a spur-wheel (N) on the back gland of the boring-cylinder, causing this wheel and its pinion (Y) in gear (which is placed on the screw (U *u*) similar to the cam-wheel on the front part of the piston for producing the rotatory motion) to revolve and consequently to turn this screw, thus shoving the movable part of the apparatus gradually forwards on the frame (P) to the extent of the width of $1\frac{1}{2}$ turns of the screw, or about $\frac{1}{2}$ inch during one revolution or 24 strokes of the boring-piston (approximately the proportion of the gear being 3 to 2).

When the hole has been drilled the desired depth, the compressed air must be shut off and the boring-piston brought out of gear with the back wheel (N), after which the apparatus can be worked back the distance required for starting a new hole, by means of a bevelled hand gear (E F), which is attached respectively to the end of the screw (U *u*) and to the frame (P), and serves also for adjusting purposes.

Further explanations of the position and use of the different parts of the whole apparatus are given in five elevations, one top view, and three vertical sections, on the Plates VI. and VII., on a scale = 1″ to 1′ ($\frac{1}{12}$); as also the sketch representing a position of the boring-apparatus on the face of a drive, drawn on a scale $\frac{1}{24}$ of natural size.

(A *b.*)—IMPLEMENTS AND MACHINERY USED IN BORING FOR SOLID MINERALS AND WATER.

This subject may be divided into the following five sections: –

I. The *preparations for borings*, and the whole *surface apparatus*, such as boring-shafts, winding, lever, and balancing-gear, &c.

II. The *boring-gear and connecting tools*, as used either within the hole or on and above the surface, and the *boring instruments*. The latter are, again, *cutting tools*, or instruments used for boring into soft or disintegrated ground by rotatory motion, and *percussion tools*.

III. The *operation of boring*.

IV. The *cleansing, trimming, and enlarging process*, with numerous instruments, as the mud-pump, spring- and ring-chisels, &c.

V. The *auxiliary apparatus* for lining a borehole, and for extracting broken or detached boring implements, &c. To this large section all the catch instruments belong, as well as those constructed for special accidental work, and for riveting, lowering, withdrawing, and suspending the tubes, &c.

All the principal implements and apparatus referring to the 1st, 2nd, 4th, and 5th sections are represented in the Museum by models and (partly) by sketches and drawings, with a full description of each and that of the boring operations of the 3rd section. The principal measurements are given for the greater part of the described models, and an approximate scale laid down to each of the illustrations in the plates.

I.—SURFACE APPARATUS, ETC.

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3,888 MODEL OF A VERTICAL SECTION OF A TIMBERED BORING-SHAFT. Scale, $1\frac{1}{4}''$ to $1'$. (Plate X., figs. 1–7.) Showing the arrangement of the hand-boring and hoisting-gear on the surface, and the mode of forcing iron pipes straight down a borehole without interruption of the boring process, by means of a powerful screw-jack in connexion with an iron guiding-tube.

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3,888 continued. The *shaft* in the model represents one of the usual dimensions adopted, measuring in its horizontal section $4\frac{1}{2}$ feet by 7 feet, by a depth of 32 feet. About 8 feet above the mouth of the bore-hole the shaft is widened on three sides to the height of 9 to 10 feet, within which space a strong wooden framework (A), for the support of the screw-jack, is strongly secured, in such a way as to resist any vertical or lateral pressure from below.

The *screw-jack* consists principally of the two strong screw-bolts e and e', which are vertically and oppositely fixed between the stout caps R and the sleepers T of the framework (A), leaving a clear height of $6\frac{1}{2}$ to 7 feet for inserting and coupling additional pipes of 5 feet length.

Over these two screw-bolts a *collar* (V) (see fig. 7) is placed, which, after being fixed with its corresponding rim on the top of the new pipe P, is forced down by an equal turning of the two hexagonal screw-knots *i i*.

To prevent the bending of the pipes in the lowest part of the shaft underneath the frame, in consequence of the force applied from above, and to guide them in their downward course, a strong iron tube (C) (see fig. 6), of an inner diameter sufficient in width to allow the inserted boring-pipes to pass freely, is fixed centrally and perpendicularly over the borehole, and secured in its position within the top of the borehole and the two stages formed by the planks *p p* and *o o*.

As soon as the collared and open top pipe P of the whole column L has been gradually lowered (in accordance with the increased depth of the bore-hole) as far as the stage J, and without interrupting the process of boring, the screw-knots *i i* have to be loosened and turned the reverse way until they touch the caps R R of the frame, after which the collar has to be knocked off and raised and a new pipe inserted, joined to the column and collared as before. The boring is interrupted only so long as is required for screwing on and off from the main set of iron rods in action, the one within the frame, to allow the additional pipe to be inserted.

A new mode of joining the square iron rods, preventing them from unscrewing during the progress of boring, is likewise represented in the model and in the accompanying sketch, as also in the figs. 3–5 of the Plate X. To the base of both the sockets of the female and male screws of each rod (*s*) a broad flange (*e*) is attached; both flanges are perforated with corresponding pin-holes—eight holes (*a*) in the upper flange of the joint, and only one hole (*d*) in the lower one, or that of the male socket—for the insertion of a bolt or pin (*p*, fig. 4) after the screw has been sufficiently brought home.

The *boring-stage* is a plain structure formed of a pair of strong oblong and well-braced frames (F F), fixed vertically and transversely upon two pairs of parallel sleepers (T T), in such a way that the whole framework encloses the corresponding mouth of the shaft (W). Two long beams (Q) are securely placed, parallel with the ground-sleepers (T T), upon these upright frames

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3,888 continued. (F F), for the support of the pulley (A′) and the boring-lever (C B), whilst the winding gear is fixed on the two main oblique stays (J), near the junction of the latter with the inner pair of sleepers. The short lever-arm is provided with a segmental head (C), from which the boring-rods are suspended by a chain (D) attached to a hook on the top of the long lever-arm (B), and about a foot beyond the axle of the lever; whilst to the hook on the end of the same lever-arm several ropes (*i*), according to the number of men employed, are fixed and hanging down, by means of which the lever is worked up and down a certain stroke.

The lettering of the surface part of the model and sketch (figs. 1 and 2) does not refer to that of the corresponding underground sections.

The principal dimensions are as follow:—*Boring-rods* (E), 1 inch square × 12 feet long; *diameter of screw-bolts* (*e e′*), $1\frac{1}{2}$ inch; *outer diameter of boring-pipes* (without sockets), $10\frac{1}{2}$ inches, and including sockets, 12 inches; *horizontal distance between the screw-bolts* from centre to centre, 1 foot 10 inches; *diameter of windlass barrel*, 15 inches; *proportion between pinions* and *driving-wheels* on the windlass-axle, 1 to 6; *diameter of sheave or pulley*, $3\frac{1}{2}$ feet; *height between the surface* and the *point of support* of the lever, $9\frac{1}{2}$ feet; *proportion of lever-arms*, 1 to 4, or 2 feet and 8 feet; *frame-timbers of screw-jack* (R and A), 12 inches × 10 inches; T, 16 inches × 10 inches; *width between the two bearers* (Q) of the lever-frame, 8 inches.

11,317 MODEL OF A LARGE BORING-TOWER. Scale, 1″ to 1′. (Plate VIII., figs. 1 to 4, and fig. 17.) With Winding and Boring Gear, worked by a Tread-wheel, as used in Germany, France, and Belgium, in large boring works for Artesian Wells, or for Coal.

In France, Belgium, and Germany, where borings have been carried on to a great depth, pyramidal boring-frames, or towers, of considerable height and dimensions, as represented in the model, are usually employed with great advantage; as, with the additional depth of an auxiliary shaft so formed, joined rods can be raised or lowered in long trains of from 60 to 80 feet long without interruption, whilst in low towers or frames, the work of unscrewing and hanging has to be done at almost every succeeding joint of the rods.

The tower is very simple, consisting of two strong trapezoidal frames of round hewn or sawn timber, joined together in an inclined position towards each other by horizontal struts and diagonal braces, forming thus a frustrum of a rectangular pyramid, on the top of which a small turret is erected for the support of the two rope-wheels or sheaves in its upper part, and the suspension of the drawn trains of boring-rods on hooks around the walls. Within the whole tower, three platforms, reached by means of ladders, are provided at different heights, one (the largest) about the middle of the tower, for the support of the men who have to guide the rods during the course of

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11.317 continued. winding; the other two, of which one forms the floor of the turret, and the other a stage about ten feet below, are for the support of the men who attend to the hanging and unscrewing of the rods. The whole is generally covered in with weather-boards, leaving only the necessary doors and shutters for the admission of men, materials, and light. To one of the broad sides of the tower, a skillion-shaped high shed of wood, also weather-boarded, is built for the reception of the machinery employed for working the boring apparatus.

In the model, the moving power consists of a *tread-wheel*, which, though usually employed for winding only, is frequently used, instead of working a double-armed lever; it is worked by men acting either on a cross-bar or pulling the strings at the end of the long lever-arm, for which purpose a boring-drum, provided with three or four rollers (in some cases a cam-wheel), is placed on the axle of the wheel, and brought in gear with the end of the boring-lever, which thus is either pressed downwards if double-armed, or lifted by its head if altered into a single-armed lever (as seen in the model, drawings, and sketches). The wheel is thus continuously worked around. The tread-wheel can be arrested by a powerful brake placed below the wheel, which is generally of a size and weight to equalize the sudden jerks communicated to the axle and framework after the end of each stroke of the lever, and is constructed in such a way as to allow half of the gang of treaders to work within the wheel. The two rope-drums, used for raising and lowering the rods without intermission, are placed loose on stationary clutch-boxes, right and left of the boring-drum, and can be brought in or out of action by an outrigger, during the time of winding or boring. The *lever-bar* acts downwards, and is recoiled upwards by a *wooden spring*, both being fixed within separate upright frames, one opposite the other, but isolated from the tower framework, and keeping the armed axle of the tread-wheel at right angles in the middle.

For cleaning the bore-hole by means of a mud-pump, &c., suspended from a rope, a trundel-shaped windlass of large diameter, situated between the shaft and tread-wheel, is employed to receive and work the rope, which passes first over a pulley fixed above the middle of the shaft to a strong frame on the first platform.

EXPLANATION OF LETTERS ON THE PRINCIPAL PARTS OF THE MODEL.

(The letters in brackets refer only to the sketches figs. 1 to 4, 17, on Plate VIII.)

A.—*Main Sleepers* to support the tower.

B.—*Main Vertical Frames of Tower,* tied together by horizontal stays G.

C.—*Porch,* to cover the projecting spring H, serving also as entrance for the men.

D.—*Turret,* for the support of the rope-sheaves F F. Within this turret, and above the second stage L', in the upper part of the main tower,

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continued.

the drawn and unscrewed rods are suspended, four at a time, to a length of about 72 feet, from between rectangular hooks J, fastened to a horizontal wooden bar of the frame in front of the two ropes, and about 2 feet from the respective floors L' and L, on each of which one man stands, who attends to the unscrewing and suspending of the rods, or bringing them into use.

L.''—*First Stage* in the main tower, for the support of a man, who guides the ropes or the rods into a vertical position during the winding process.

M.—*Beam*, secured to a vertical stool-frame on the stage L'', to suspend from it the block N, which, in connexion with the windlass O, is used for light lifts, but principally for cleaning the borehole by means of the mud-pump. (Museum No. 10,737, Plates III., XVII.)

P.—*Tread-wheel* (W), worked by four men on its outside. The power of the men is applied at not above 45° from the level of the axis of the square shaft S. If the holes reach a depth beyond 400 to 500 feet, two or three additional men work inside the wheel, for which purpose the shrouding is to be floored on the inner side and provided with steps, formed by battens nailed across at intervals of $1\frac{1}{2}$ feet. The steps Q of the tread-wheel are fixed radially (44 around the periphery).

R.—*Movable Steps*, with which a wheel is provided, when the men have not only to work nearly at the top of the wheel at an angle of 64° to the level of the axis, but also alternately on both sides of the wheel.

I.—*Boring-shaft* (H), timbered, of a depth varying from 20 to 70 feet. The whole tower is boarded in, leaving along its sides a sufficient number of shutters for the admission of light.

S.—*Square Wooden Shaft*, on which the tread-wheel, boring-drum, and the boxes *b b'* of the winding-gear are fixed.

T T'.—*Two Rope-drums* (F F', figs. 3, 4, 17), of equal size, of which each is provided on one side with three clutches around the circular opening. They revolve on the respective boxes *b b'*, which are also provided with corresponding clutches, so that, when both sets of clutches are brought into close contact, the rope-drums must then revolve with the shaft.

V.—*Outrigger* (Y, *i*, b), in connexion with the two loose rings W, around the naves of the rope-drums, for bringing the drums either in or out of action. When the latter is the case, the outrigger acts also as a brake to prevent the drums from revolving; but a separate brake for this purpose is in most cases provided.

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11,317 continued. U.—*Stationary Boring-drum* (R), provided with three iron rollers (*a*) for working the lever-bar L. The wheel makes from five to six revolutions per minute (from three to four only during winding), producing thus about fifteen to eighteen lifts of the borer.

s, t.—Two separate ropes, fastened in opposite directions to the respective drums T (F), which act simultaneously, so that one of the ropes is always coiling in whilst the other is paying out.

Y.—*Overground Frame* (T'), for the support of the lever-bar L.

Z.—*Overground Frame* (T), for the support of the horizontal spring H (Q). Both of these frames are braced, and fixed underground to a depth of at least 5 feet.

H.—*Horizontal Spring* (Q), to recoil the blows of the dropping lever L on the wooden knob or head *f* (N) on the top of the foremost part of the upper plank of H. The spring consists of four layers of stout and sound planks of deal, which are of different lengths, one projecting beyond the other, from the lowest upwards, by $2\frac{1}{2}$ feet in front of the frame Z (T), within which the full set of planks are fixed by means of the wedges *r r'*.

c c' (*t t'*).—Two iron bolts or pins to rest the lever on when out of action.

e.—*Post* (P) for causing the spring to recoil.

g.—*Hook* to suspend the boring-chain from the lever-bar L.

II.—*Brake*, worked by the lever-handle K, for stopping the wheel when required. The short interval caused by the stoppage of the wheel during the act of pulling up or letting down the rods, is employed by the men in and on the wheel to change their position from one side of the wheel to the other.

PRINCIPAL DIMENSIONS.

Boring-shaft, 6 feet square; its depth 20 to 50 feet.

Square Shaft of Tread-wheel, 20 inches square by 24 feet length.

Height of Tower from surface to floor of turret, 55 feet; height of turret (to top-plate), 13 feet.

Width of Tread-wheel, 8 feet, } sufficiently large for placing four men
Diameter of Tread-wheel, 16 feet, } inside and four men outside the wheel.

Diameter of Rope-drums, $5\frac{1}{2}$ feet.

Radius of Boring-drum (to centre of rollers), $1\frac{3}{4}$ to 2 feet.

Boring-lever, distance between its axis and point of contact with the roller (when level), 12 feet; distance between its axis and the point of support for the boring-rods (*g*), 9 feet.

Height of Fall, 2 feet.

Diameter of Rope-sheaves, $3\frac{1}{2}$ feet.

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11,317 continued. *Section of Boring-rods* (of those used in the lowest part of the hole), 2 inches square.

Lever-bar (L), 14 inches broad, 9 inches thick; front part, 4 inches × 9 inches.

Length of each Boring-rod, 18 feet.

Weight of each Boring-rod, $1\frac{1}{2}$ inch square × 12 feet long, 90 lbs.; 2 inches square × 18 feet long, $2\frac{1}{8}$ cwt.

Weight of a 12-inch Chisel, 150 to 200 lbs.

Weight of a Main Rod, $2\frac{1}{4}$ inches square × 12 feet long, $1\frac{3}{4}$ cwt. to 200 lbs. (for boring holes of 50 to 200 feet in depth).

Weight of Main Rod, $3\frac{1}{2}$ inches square (chamfered) × 18 feet to 22 feet long, 750 to 900 lbs. (for boring holes of 1,000 to 1,500 feet in depth).

10,503 MODEL OF A SMALL PORTABLE BORING-TOWER. Scale, 1″ to 1′. (Plate VIII., figs. 5 to 7.) As used in Germany, for boring holes of a depth from 50 to 300 feet.

The timber used in the construction of this pyramidal, portable apparatus (A) is either round, hewn or sawn, and of very slight dimensions. The vertical height of the tower from the surface-frame is about 24 feet, 10 feet square at the bottom, and $4\frac{1}{2}$ feet above. It consists principally of two separate horizontally-braced frames (D D′), of a trapezoid shape, which are erected and fixed on ground-sleepers (O), and joined and bolted together by four to five horizontal stays (G), at an uniform angle all round. A strong windlass (W), for raising and lowering the rods, &c., is placed outside the tower (A), but opposite the lever (L), on stools (J), fixed and braced respectively to the ground-sleepers (O) and to one of the horizontal ties (G). Its barrel (T), 15 inches in diameter by 8 feet in length, is provided with movable saddle-discs (T T′) to keep the rope in the middle, whilst to one of its ends four long horns (*t*), similar to those on a winch, are fixed crosswise, to be used by additional hands in case of applying greater force. On the square top of the tower (A) a broad and deep-channelled pulley (H), 2 feet in diameter and connected with a plain tackle (E′, C), consisting of only one block (E′), revolves within fixed iron bearings, the rope end being fastened to a hook which is attached to a cross-timber opposite the axle of the pulley.

The *Lever* (L) and *Spring* (Q) being adopted in this apparatus, they are placed in separate frames (T and T′), fixed to cross-sleepers underground—the first in front and partly within the tower, and the latter behind the long lever-arm, recoiling downwards. The lever (L) is placed about $3\frac{1}{2}$ feet above the ground (K), and worked by hand on a long crossbar (N), 10 to 12 feet long, at the end of its longer arm underneath the head of the spring (Q). It is $10\frac{1}{2}$ feet long from end to end, by a section of 5 inches × 4 inches, and its distance between axle and hook, for suspending the chain and rods,

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10.503 continued. from 3 to 4 feet. The axle works in semicircular open notches. of which two corresponding rows, four in each, are provided for shifting the bar.

The *Spring* Q is similar to that described in the large tower (Museum No. 11,317), and consists of three 10 to 15 inch × 3 inch deal planks, from 9 to 7 feet in length, horizontally placed and securely wedged within its vertical frame T′. To bore with effect, and to prevent accidents from breaking of sliding-joints and chain, &c., the spring must be adjusted so that 1 inch to 2 inches playroom remains always between the touching-points of both the spring and lever. A shallow shaft (S) is sunk from 6 to 10 or more feet in depth × 4 to 6 feet square, keeping the centre of the borehole in its middle, to allow the raising or lowering of long trains of joined rods, and to give more room for working the rods underneath the lever during the act of boring, as also to permit the adoption of low towers and low spring and lever frames. A surface-pipe (R), to secure the mouth of the borehole, is also inserted and tightly rammed in, projecting about 18 inches to 2 feet above the bottom of the shaft.

A long ladder is generally fixed permanently to one of the sides of the tower to reach the top.

PRACTICAL NOTES AND DIMENSIONS.

The number of men required for carrying on borings with a hand-lever apparatus similar to that described varies with the depth as also with the width of the borehole. Their labor is chiefly divided into working the lever, turning the rods, winding, and screwing on or attaching and detaching the rods. A competent boring-master is placed in command of the men, of whom not more than three (with the assistance of the master) are necessary for boring a hole to a depth of 60 to 70 feet, viz., two at least for working the lever and attending to the winding when boring has ceased, and one for screwing off and on the rods and the swivelled handle of the winding gear, whilst the boring-master attends to the turning of the rods during the boring or to the support of the rods above the stage, &c., by means of a key or the forceps during the winding.

If the hole be continued beyond the above depth, more men must be placed on the lever, or about one man for every additional 80 feet, so that in deeper holes, with a proportional working-gang, and by the employment of boring-rods $\frac{5}{4}$ inch in section, about 42 strokes per minute, with a lift of 9 to 10 inches, can be performed; the alternate recoiling action of the lever, produced by the wooden spring and post, greatly assisting the effect. After 90 to 110 strokes, equal to 2 to $2\frac{1}{2}$ minutes, there is generally a spell of 1 to $1\frac{1}{4}$ minute, which amounts to nearly one-third of the whole shift, excluding the time taken for meals.

Museum No.
10,503 continued. *Depth of Lever and Spring-frames* under ground, $4\frac{1}{2}$ to 5 feet.

Size of Spring-planks, 9, 10, and 11 feet in length; 15 inches wide, by 3 inches thickness.

Height of lowest plank of spring above ground, 5 feet; *projection of same beyond frame*, $4\frac{1}{2}$ feet.

Distance between middles of both frames, 12 feet.

The accompanying Plate IX. represents, in figs. 1 to 7, the whole surface apparatus, as employed by M. Degousèe, for boring holes of considerable depth. It consists of a high, wooden, pyramidal tower (H) in connexion with the boring, winding, and balancing gear (D, z, t; W, R, a; Q, P, U); the whole arrangement and construction of the apparatus being similar to that represented in the Drawing II., No. 18,880. The percussive action is, as usual, produced by a ponderous double-armed lever-bar (D), which is placed at half-height in the middle of the tower, and provided with a movable axle (w) for the regulation of the stroke; the proportions of the lever-arms vary from 1 : 3 to 1 : 4. The borer and its appendages are suspended from a hook (x) on the end of the shorter arm of the lever, whilst the eye (r) on the opposite end of the arm is connected, by means of a swivelled rod (z), with a single-armed lever (t) below, and thus indirectly worked by the action of a cam-wheel upon the head of the latter; the cam-wheel (N) being fixed on the axle of the barrel (J) and driving-gear (R, S) of a windlass (W), which is alternately used for winding purposes in connexion with a pulley (a) on the top of the tower. The hook (x) and eye (r) on the ends of the lever (D) form the ends of a piece of flat-iron bar, fixed by means of iron straps and screws to the top-face of the lever. The tower is strengthened on each side by means of two pairs of cross-braces (d), nailed one above the other against its corner timbers (H), which are securely tenoned and anchored to a corresponding ground frame-work (A), horizontally supported on heavy cross-sleepers, and of sufficient extent towards one side for the reception of the windlass.

The *Balance-bob* (Q, P), for balancing the portion of the boring-train above the sliding-joint (*see* No. 10,708, and Plate XI., fig. 11), is placed opposite the windlass, and consists merely of a heavy double-armed lever-beam, of which the one end is attached and pinned to the boring-chain above the handle (F); whilst from the other end a weight—usually a wooden tub (P) filled with stones—is suspended. Two or three men are able to work the lever on the windlass, saving thus, by this combination of levers, a great deal of motive-power. V and T are the framework for the support and guidance of the single-armed lever (t); U and G, the stool-frame for the support of the lever (Q) of the counter-weight (P), and the beam C the cross-sleeper for support of the axle-block of the main lever (D).

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10,503 continued. The average height of a tower of this description is about 25 feet, by a base of 10 to 12 feet square, drawn in at the top about 1 foot × 4 feet; the whole length of the lever from 10 to 12 feet; the diameter of the pulley about 2 feet, and that of the cam-wheel $2\frac{1}{2}$ feet.

Fig. 1 represents a side elevation of the tower and attached gear; fig. 2, the front elevation viewed from the windlass; and fig. 3, a ground-plan and partly top-view of tower, windlass, lever, and balancing-gear; fig. 4 represents the top of the eye-end (r) at the working end of the main lever D; fig. 5, front view of windlass-barrel, cam-wheel, and driving-gear of windlass (larger scale); fig. 6, side-view of cam-wheel (N) and driving-gear (R); fig. 7, vertical section through cam-wheel and windlass-barrel.

The same Plate (IX.) represents also a portable boring-stage frequently employed by M. Degousèe in narrow and shallow borings, carried on either by rotation or percussion. It consists of three stout wooden legs (B) of sawn timber, of which two are trapezoidally framed together by means of two or three transverse bars or a single oblique cross-brace, whilst the upper end of the third leg is hinged between the converging top ends of the two other legs, thus framed by means of a strong iron bolt. The lower ends of all three legs are fixed to the corners of an isosceles-triangular ground-frame (N), which again rests on two stout parallel ground-sleepers. The pulley turns on an axle passing, immediately below the hinge-bolt and parallel to it, through the tops of the framed legs, where they are also provided with wedge-shaped cheeks on their inner side, for the guiding and centring the pulley. There is no windlass directly attached to the stage, the rope passing merely from the pulley over a roller underneath the ground-sleepers, to be drawn by one or two men for the purpose of lowering or raising the rods, tubes, &c. The single back-leg serves also as a ladder, by being provided with iron or wooden rungs, or sometimes triangular brackets, at regular intervals of about one foot along its whole length, keeping the leg in the middle *Vertical height of Stage*, 18 to 20 feet; *Pulley*, 16 to 18 inches diameter; *Triangular Ground-frame*, 13 feet × 13 feet × 9 feet (on the average).

Another simple structure of a portable, easel-shaped hoisting-frame, frequently employed in rotatory borings, is represented in Plate X., figs. 8 to 10. It is made of strong grown or sawn timber, and consists of a steeply-inclined trapezoidal frame (T), hinged at the back of its top rail (F) by means of two axle-bolts to the T-shaped and axle-bearing head (L) of a single leg (S). The vertical height of the frame is about 16 feet, and the width of its base (E) 7 feet, and top (F) 4 feet, the rails of which, however, project about 1 foot or more beyond each side. The block (i) in which the pulley runs, and through which the rope passes, is suspended from a strong and broad iron strap (i) fitted over the middle of the top rail (F) of the frame (T); whilst across the lower part of the latter, and at working height from the ground, a windlass-barrel (W), for the reception of the pulley rope, is

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10,503 continued attached, the axle of which turns in iron bearings screwed to the front of the long timbers (T) of the frame. The framed front part (T, E, F), and the hinged T-shaped leg (S), are generally coupled together, about 7 to 8 feet above the ground, by means of two long iron hooks (*t*), which are hinged to the side timbers (T) of the first, and fastened to eyes on the sides of the latter, so as to prevent both portions of the whole hoisting-frame from spreading beyond a given distance, when a great weight is suspended from the rope. R is the projecting wooden surface tube of the borehole, and *d* the horizontal double-armed lever-handle, screwed to the top rod, and worked by two men, as seen in the sketch.

10,504 MODEL OF A SPRING AND LEVER FITTED INTO ONE FRAME. Scale, 1″ to 1′. Plate VIII., figs. 8 and 9.

This arrangement is generally adopted in deep borings, when the tread-wheel, or any other apparatus in lieu of it, is used *only* for the purpose of raising or lowering rods, tubes, &c.; also for saving room within the tower.

The single frame, containing both the spring (N) and lever (L), consists of two strong, oblong, well-braced stools (T), fixed apart by the width of the spring (L) to stout cross-sleepers (Q and R), in front and back, on the surface of the ground. The front uprights of the framework are mortised and wedged into the sleeper (Q) near the edge of the shaft; whilst the back uprights, besides being bolted to the ground-sleeper (R), are braced (C) and fixed to a single horizontal cross-beam underneath the ground. The spring (N)—consisting of five deal planks, wedged in the usual way (by wedges *i*, *i*, *e*, *e*), but obliquely within the frame—and the lever, when at rest and touching the head of the spring, are inclined nearly at equal angles (6 degrees) toward each other; the lever (L) to be worked by hand, on the crossbar (M), is a single, square, wooden bar, supported on an iron axle within the frame, in the manner adopted in those described before (No. 10,503 and No. 11,317), with the only difference of its being guided within iron bars, fixed between the two front uprights of the frame; P is the hook from which the boring-train is suspended.

DIMENSIONS.

Height and Width of each stool above ground, 11 feet × 5 feet.

Section of upright timbers, 8 inches square.

Lever, 16 feet long from hook to handle; section, 9 inches × 5 inches.

Spring, five planks, ranging from 7½ feet to 14 feet in length; section of each plank, 3 inches × 18 inches.

Distance of Springhead from ground, 5½ feet.

Angle of incline of Spring, 6 degrees.

Height of Lever-axle from ground, 2 feet 9 inches.

Proportional Length of Lever-arms, 5½ feet and 10½ feet.

Length of whole Handle or Crossbar, 15 feet.

Section of Surface-sleepers, 10 inches square.

MODELS REPRESENTING THE METHODS OF BORING HORIZONTAL HOLES, EITHER BY PERCUSSIVE OR ROTATORY MOTION.

Horizontal borings are often employed over ground, in searching for springs on hill sides, and for examining the mineral contents of the rocks of sloping grounds, as also for draining or ventilating those parts of workings of mines situated above the natural watercourse of valleys. For bridges and roads horizontal borings are also employed, in order to drain the soil which forms the walls of the excavations and cuttings, and for the consolidation of the dams of railroads, common highway and water reservoirs, by timbered draining-flues. In underground workings these borings are frequently used, and in many cases are almost indispensable, for examining dislocations of mineral deposits, their thickness, &c.; also for establishing communication between parts of a mine, which are otherwise difficult to be worked, on account of bad ventilation; for examining and tapping old workings, so as to prevent any sudden and dangerous contact with foul air or water accumulated in them, &c.

The dimensions of the boreholes vary with the nature of the work they are intended for; but all of them are subject to several difficulties, such as the friction of the bore against the side of the borehole, that no water can be introduced into a level hole, and that it is difficult to prevent the borehole from becoming oval; but they are seldom of any great depth, and if a slight inclination be given to the holes, small quantities of water can be introduced and retained in them.

This system of boring requires very little height for fixing the apparatus, and can therefore easily be placed in subterranean galleries. Those constructions are generally considered the best in which the percussion is produced by the action of a weight. Horizontal borings by rotation, however, which are only applied in soft rocks, as those usually containing coal, lignite, rock-salt, &c., require only a simple and portable stage, similar to that employed for boring wooden water-pipes.

The two models here described represent the boring machines employed in France, of which the one for boring by percussion (No. 22,262) is more calculated for being employed over ground; and it is, therefore, of a stronger make than those employed under ground.

MODEL OF A BORING APPARATUS EMPLOYED FOR BORING HORIZONTAL HOLES BY ROTATION. Scale 1" to 1'. Plate VIII., figs. 13 to 16.

The simplest form of a stage employed for this kind of boring resembles a common mining windlass, only narrower, and fitted with a short thick roller or barrel without the usual handles. This apparatus is found to answer the purpose perfectly if holes have to be bored to a depth of only 10 or 20 feet,

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fixed opposite and near the face of the ground to be pierced. An iron rod, furnished with a shell-auger, and armed with a T or cross handle, is then placed in such a way on the roller that it lies in the plane of the intended borehole. Two men work on the handle, and press the borer as they turn it, in the same way as carpenters do when boring a horizontal hole in wood. The only precaution which is necessary, is to allow but little play and advance for the boring-rod, and, when they commence the work, to bring the stage near enough to the ground in order to prevent the weight of the borer causing the hole to deviate from the right direction.

If the borehole is to be continued beyond 20 feet, it becomes necessary to employ a second stage similar to the first, but furnished with a hole, or two cross-pins for the reception and support of a long guiding-rod screwed or wedged to the head of the bore-handle. By this arrangement a steady rotation is produced, and great facilities given for withdrawing the rods and cleaning the borer, as, in the latter case, the two stages serve as resting-points for the charged borer and series of attached rods. The front or roller-stage is then generally removed 7 to 8 feet farther out, and the second stage placed about 10 to 12 feet beyond it, so that at least 25 to 30 feet of rods remain unscrewed. The two stages, which may be also adopted with advantage for holes of a depth less than 20 feet, are frequently fixed on one ground-frame, as seen in the sketch. When the space allows it, and the boring is to be carried on to a depth of 120 or more feet, other stages are placed behind the second, at distances from 21 to 24 feet, which are either fixed to the ground by underground frames, or only weighted by some heavy material, thus enabling long trains of joined rods to be withdrawn without unscrewing or disjoining the rods at every joint, or in short sets of two or three rods at one time.

The augers employed in horizontal boring are of the same description as those used for vertical holes. (*See* Plate XIII.)

22,262 MODEL OF A BORING APPARATUS EMPLOYED FOR BORING HORIZONTAL OR INCLINED HOLES BY PERCUSSION. Scale, 1″ to 1.

Very near the point where the boring is to commence, an upright frame (A) is fixed firmly in the ground to a depth of 2 to 3 feet, to which, close to the surface, the ends of two long planks or square sleepers (B) are horizontally fastened, one on each side, and parallel to each other, by half-joints and screw-bolts, and the whole made firm by two stout braces (S S), also halved and bolted to their respective places. Between the vertical frame (A) a pulley (H) is placed at the height of the hole to be bored, and across the middle of the sleepers a low stage or stool frame (K) is fitted, receiving a cast-iron block (*e*), the centre of which corresponds exactly

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22.262 continued. with the axis of the borehole. Upon these two supports the drill, with its complement of joined rods, is placed, the block serving merely as a guide, and frequently as a regulating cushion by a slight modification, whilst the pulley (H), acting also as a guide, serves principally for facilitating the percussive and rotatory motions of the boring-train. The end or head of the latter is attached to a block-case (E), turning loosely in the same, whilst the opposite end of the casing is provided with a hook for receiving the windlass-rope (L). Between the horizontal sleepers (B) a heavy roller (G) with a strong axle is fixed near their ends, and above the roller (H), near the top plate of the vertical frame (A) another but tubular roller (P) is placed, turning on a horizontal crossbolt passing through the frame. An ordinary rope, or a wire-rope, which is preferable, is fixed on the latter roller (P), passing around the pulley of the block (*e*), runs back to the roller (G), and bears at its end a weight (D), which moves in an excavation made for the purpose. The axles of P and G are placed in such a position that the rope forms, with the horizontal borer, two equal angles; but as the upper line of the rope is too long in proportion to the part below the rod, and therefore liable to bend, a support is provided for it, consisting of two horizontal rollers (F, F^1), which are placed in a vertical line with the large roller (G) above the pit, and fitted within a slight vertical frame (C) fitted to the ground-sleepers. The position of these rollers is such that the above-mentioned angles will always remain equal, whatever direction the rods may take. The weight (D) pushes the chisel towards the rock-face, which is to be pierced in the direction of the axis of the system in such a manner that if, by the aid of the windlass (M), the borer is retracted a certain distance and then suddenly released, the bore-bit will knock against the rock face with the velocity communicated by the weight. The rope is generally two or three times coiled around the barrel of the windlass, the bottom of which lies in one plane with the axis of the bore. One or two men work the windlass, and a third holds the end of the rope, which, by pulling it tight, produces sufficient friction to draw the rods whilst the windlass is in motion. By keeping thus the windlass in continual motion in one direction, and alternately pulling and releasing the rope, a regular percussive action may be produced. A sufficient number of short rods for regulating the length of the rope (*i*), and consequently the movement of the attached weight (D), must be always at hand, and made, as well as the guiding rods (J) and the shaft of the borers, of round iron.

A ratchet is frequently attached to the axle of the roller (P), which is then to be solid, for regulating the rope (*i*) by rolling its end around the roller (P). instead of merely tying it. For turning the borer at the end of one or several strokes, a double or four-armed handle is fixed to the rod (J), either in front or behind the guiding-stage (K).

II.—BORING GEAR, CONNECTING, CUTTING, AND PERCUSSION TOOLS.

(Museum Nos. 10,699 to 10,752.)

FIFTY-FOUR MODELS OF THE PRINCIPAL BORING GEAR AND INSTRUMENTS, AS USED IN DEEP AND SHALLOW BORINGS FOR WATER AND FOR SOLID MINERALS.

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10,745 THE SWIVEL (Drawing III., XVIII.); Plate VIII., fig. 1, and Plate IX., figs. 12, 13.

This instrument is used to regulate the stroke of the borer, which is effected by turning the screw (L) either up or down within an oblong iron frame (J). A guide (N) is attached across the middle of this frame, for giving the screw a vertical direction and preventing it from bending. The swivel is placed between the boring-chain and the universal-joint, and bolted to the latter as seen in Drawing III. and Model No. 5,841.

10,713 THE UNIVERSAL-JOINT AND HANDLE (XIX., Drawing III.); Plate IX., figs. 12, 13.

Both are always connected; the socket of the handle is joined to the top rod, whilst the universal-joint is bolted to the swivel-frame above. The "*Handle*" is a transverse bar of sound hardwood, fitted into a corresponding eye of a short socket-joint. It is used to turn the borer gradually around during the act of boring, and also when a hole is to be examined for the recovering of broken or detached portions of rods, &c. It is generally managed by one man, but it must be long and strong enough to be worked by two men if needed. The sketch represents a cross-handle formed by two eyes. By means of the "*Universal*" the rods can always be kept in the centre of the hole, which position prevents the borer and the rods from being subjected to jamming or sudden jerks.

22,268–69 KIND'S SWIVELLED HANDLE-JOINT—Plate X., figs. 15, 1, 8, 9; Plate VIII., fig. 5; and Plate IX., figs. 1 and 2; also *see* Model 11,317, where they are attached to the ropes—as adopted in large borings, for raising or lowering rods, &c.

It consists of a strong wrought-iron ring (b) of an oval form, which is drawn out into a socket on one of its flat curved sides, so as to serve as a handle by being screwed to the male-socket of the head-joint (c), whilst to the part of the handle opposite to the socket a smaller oval ring (a), to which the rope is slung, is joined by a common swivel-bolt.

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22,271 SWIVELLED HEAD-JOINT, generally employed in working the mud-pump, but also, if made of larger dimensions, for suspending heavy trains of rods, &c. (*See* Model No. 11,317, attached to the windlass rope; also Plate X., fig. 13, and Plate IX., figs. 1 and 2.)

Another kind of swivelled tool, employed for suspending the rods during withdrawal, is the CROW'S-FOOT (Stangenschlüssel). It is supported by the stage or surface-pipe of the hole, as also by the hand of the man in attendance, and frequently, in addition, by a suspended rope attached to the swivel (F), whilst the socket of a rod is rested upon the projecting claws (A) and the upper rod is being screwed off. (*See* Plate X., fig. 12.)

10,719–21 MODELS OF THE THREE DIFFERENT-SHAPED WROUGHT-IRON KEYS (XXII., XXIII., XXV.); Plate IX., figs. 10 and 11; Plate X., figs. 11, *a*, *b*.

The principal tools employed for supporting the rods above and across the mouth of a borehole, as also for detaching or for joining them. Figs. 10 and 11 are of great strength, and exclusively made for working rods of large dimensions, whilst figs. 11, *a*, *b*, Plate X., as also the key, generally called a Scotch, and represented in fig. 14, Plate X., are only employed in light and especially rotatory borings. The latter key resembles the key fig. 11, Plate IX., with the exception of its head being drawn out into a short horn in one line with the axis of the key, to support and partially aid the action of the left hand of the man, whilst the right one is principally working the opposite main handle.

10,706–7 WROUGHT-IRON BORING-RODS (XXIV. and XXXI.); Plate XI., figs. 1 and 2; figs. 3, 4, 5, and 6.

These rods must be made of the best tough rolling iron, of a medium hardness, and free from all faults. They are generally joined in one of two ways, either by means of screws and sockets or by means of fork and tongue attached to their respective ends. The first mode is almost universally adopted; the male screw is kept always below, and the corresponding female socket above, by which arrangement the screws can be easily kept clean and in good working condition. The other kind of rod-joints have the tongue (which is about 15 inches to 18 inches long) above, and fitted tightly into the corresponding fork of the lower rod, whilst the whole joint is fixed by three or four transverse screw-bolts. The dimensions of all the joints of one set or train of boring-rods must be necessarily made according to a uniform scale, so that they may be changed into any relative positions throughout the whole depth of the hole, without causing delay or confusion. The iron rods are principally made of a square cross-section, which form is found to be the cheapest in forging and for keeping in repair, as also most convenient in all manipulations,

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10,706 10,707 especially for the application of the keys, &c., for supporting, detaching, or joining the rods. The sockets of screw-joints are in all cases made of a round form, but frequently of great length (12 inches to 14 inches), for the purpose of providing them with corresponding key-faces, which are cut out in different ways, as seen in Plate XI., figs. 3 and 4, whilst the ordinary or old boring-rods have short sockets (3 inches to 4 inches), and are provided with a collar about 9 inches to 12 inches below the male socket for their principal support on the stage (figs. 1 and 2); it is also usual, if the rods are longer than 6 or 8 feet, to attach a second collar to their middle. The screws are generally made 2 inches long, having four to five threads to the inch; they are, however, frequently made about $1\frac{1}{2}$ inch to 2 inches longer; this additional part is then turned bare of the thread, in order that the corresponding female screw be guided to catch at once the threads of the entering male screw. Some of the forked rod-joints, which have slightly tapered tongues, are forged round (*see* Model, 10,732), whilst those with *parallel-sided tongues*, as also the *half-notched joints* (Plate VIII., figs. 20, 21), are made square, and conform with the rods. Nearly all the forked joints are fitted by a dovetail.

The size of the rods depends on the depth and width of the hole, as also on the system adopted in boring it: thus, boreholes of a depth of 100 feet to 150 feet require rods of $\frac{3}{4}$ inch to 1 inch in thickness (principally for rotatory boring); 200 feet, 1 inch to $1\frac{1}{8}$ inch; 600 feet, $1\frac{1}{4}$ inch; 800 feet, $1\frac{1}{2}$ inch; and 1,000 and more feet, $1\frac{3}{4}$ inch to 2 inches. It is always customary to make the rods stronger than really required for the purpose, so as to avoid vibrations, and consequently their destructive contact with the walls of the borehole. The best approved length of the rod is from 14 to 15 feet for deep borings, although they are frequently made from 18 to 25 feet in length; in holes of a depth from 100 to 150 feet, however, rods of 6 to 8 feet in length have been found in all cases quite sufficient.

10,706 XXXI. MODELS OF A PAIR OF SMALL BORING-RODS—Plate XI., fig. 2—as used (by Kind) for narrow and shallow borings, as well as, in connexion with the mud-pump, for clearing out stiff and clayey sludge; $\frac{7}{8}$ inch square; sockets, $1\frac{2}{3}$ inch diameter; screw, $\frac{3}{4}$ inch diameter; length, 12 feet.

10,707 XXIV. A SET OF LARGE BORING-RODS, which are only for deep and wide borings. Sockets, $2\frac{1}{2}$ inches diameter; section, $1\frac{1}{2}$ inch square; length, 12 feet. (*See* also the long trains of heavy rods suspended in the tower of Model No. 11,317.)

The accompanying Plates represent the principal forms of boring-rods especially employed by French boring-masters. Thus, Plate XI., fig. 3, 3*b*, A PAIR OF WROUGHT-IRON SQUARE RODS, of a

Museum No.
10,707 continued. medium size, for deep borings, with long sockets provided with a pair of corresponding *key-faces* cut into each of them: 3*a* is the *socket-joint*; 3*b*, a vertical section of the *female socket*, showing the depth of the key-faces; 3*c*, a *top-view* and *cross-section*. Sockets, $2\frac{1}{4}$ inches diameter by 8 inches long; section, $\frac{5}{4}$ inch square: length, 15 to 16 feet; weight of rods, per yard, for 600 feet depth, 24 lbs., whilst the weight of those for small holes is about 10 lbs. per yard.

DEGOUSÈE'S MAIN BORING-ROD—Plate XI., fig. 4—provided with a short female socket below, and a long key-faced male socket above; the key-faces of this rod are formed by flattening out the lower part ($\frac{3}{4}$) of both sides of the socket, so as to form equal planes with the corresponding faces of the rod (With side view and vertical section of female socket.)

This rod being usually employed as a main, by being directly attached to the boring tool, is sometimes made of larger dimensions than those represented in the figure. A main rod of $1\frac{7}{8}$ inch to 2 inches in section, with proportional sockets, weighs about 40 lbs. per running yard.

DEGOUSÈE'S SHEET-IRON TUBULAR BORING-ROD (T)—Plate XI., fig. 5—with wrought-iron tubular sockets (F), and joined together by means of a key and the usual screw.

These rods were invented for a new system of boring holes through rocks of a clayey or calcareous nature, or any rocks which possess a certain degree of cohesion. It was sought to supersede the tedious work of screwing and unscrewing, lowering and raising the rods in the ordinary system of boring, by introducing a continuous current of water into the tubes during the act of boring, thus causing the loosened materials to be forced upwards by the strength of a reversed current of the water through the annular space between the walls of the holes and the sides of the tubular rods. This system has, in many instances, perfectly answered the purpose; but there are still a great many objections to it, especially on account of the amount of water required, and from choking the annular passage by occasional large pieces of rock impeding the movement of both the borer and the materials loosened. The borer attached to the head-rod is a kind of ring-chisel, similar to those described below, and fastened by means of screw-joint of rivets. The tubular rods are also used in borings on the Chinese system, viz., by the rope serving to prevent the hole from taking a crooked course.

The outer and inner diameters of these rods (T) are respectively 2 inches and $2\frac{1}{2}$ inches, and their length from 12 feet to 21 feet: outer diameter of socket-joint, $3\frac{1}{2}$ inches; length of each socket-head, $3\frac{1}{2}$ inches; length of attached tubular neck, $3\frac{1}{2}$ inches to 4 inches; inner diameter of same, $1\frac{1}{2}$ inch.

Fig. 5 represents a vertical section of a tubular rod; 5*a*, a side view of the upper portion of the rod; and 5*b*, a top view and a horizontal section.

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DEGOUSÈE'S SHEET-IRON TUBULAR BORING-ROD—Plate XI., fig. 6—in which the soldered or riveted tubes are fixed at both ends by means of bolts or keys, and in some cases entirely soldered to corresponding short and solid shafts attached to the short square neck of the respective female or male sockets of a screw-joint, as in the mode of fixing the tubular casing to the socket-joints of the wooden boring-rods.

Every precaution has to be taken in their manufacture to keep all the joints perfectly watertight, so as to prevent the tubes filling with water, which would only tend to produce injurious concussion upon the rods derived from their powerful percussive action. As a preventative to such effects, the space within the tubes is frequently fitted up entirely with wood, which improvement not only answers perfectly, but also increases greatly the stability of the rods. Having a large section, the tubular rods are less liable to vibrations and torsions than the common square iron or the wooden boring-rods. With respect to weight, the wooden are considerably lighter when compared with the tubular rods per lineal foot, whilst equal lengths of the latter rod and the square iron rod are generally made equal in weight. The adaptability of these tubular rods to rotatory borings has been proved in many instances. The dimensions of the tubular rods correspond nearly with those of the wooden rods, and the tubular iron rods with tubular joints. Length, 18 feet to 21 feet; inner diameter, $2\frac{1}{2}$ inches to 3 inches; length of socket, including neck and round shaft, 12 inches; weight of a rod and sockets, 21 feet long, $1\frac{1}{2}$ cwt. to $1\frac{3}{4}$ cwt.

10,710-11 MAIN BORING-ROD AND GUIDE (XXXIII. and XXXV., Drawings I. and III.); Plate XI., figs. 8, *b*, *c*; figs. 13, *b*.

In former times the boring tool was generally attached to a boring-rod of the usual dimension for deep borings, viz., $1\frac{1}{4}$ inch to 2 inches in section. This produced not only a great many accidents, caused by breakage of the rods the deeper the hole progressed, but also nearly half of the mechanical effect was lost on account of the continual vibrations of the rods. Although, afterwards, this was partly avoided by introducing the sliding-joint (*see* No. 10,708–9), it was still found necessary to concentrate the greatest weight within the smallest space, in order to obtain the highest possible effect from the percussive action of the armed tool. With this object, the rod next above the boring tool was made of large dimensions, or weighing about 9 cwt. to 10 cwt., which produced the desired results.

This *Main Rod* (XXX.; Drawing III.)—figs. 8, *b*, *c*—is made about 22 feet in length, by a $3\frac{1}{2}$-inch to 4-inch square section, chamfered into an octagonal shape (Y); the head is formed into a socket of about 5 inches diameter by 6 inches to 7 inches in length; which contains the female screw corresponding with male screw-socket of the boring tool. About 4 feet of its upper end (C)

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10.710 10.711 continued. are forged round to about 3 inches diameter, and either entirely used for the reception of a guide (fig. 13), sliding up and down, and provided with a male screw, without socket, for being joined to the lower part of the sliding-joint, or, besides receiving the guide on the lower 2 feet. drawn out the remainder to a shape of 2 inches by 3 inches, and provided with a slot for the reception of the forked upper part of the sliding-joint.

The *Guide* (XXXV., Drawing I.)—Plate XI., figs. 13, *b*—which is made to slide about 2 feet up and down on the round upper portion of the main rod, serves to keep the latter and its appendages, above and below, in a perfect vertical position, so that no bends can occur, nor deviation of the borer from the vertical central line of the hole.

The guide consists of a number of brackets or springs, riveted at equal distances around a short tubular shaft on the round part of the main rod. The radial distance of the springs is about 1 to 1½ inch less than the inner radius of the tubes.

10,745 BORING FORCEPS (VI.; Drawing II.); Plate IX., figs. 14, 15.

These are made of wrought-iron, and employed to catch on the top of the wooden surface-pipe (P), which is provided with a cast-iron cap (K) and projects a few feet above the mouth of the borehole, the boring-rods (fig. 15) underneath their collars or sockets (R) for unscrewing or joining them, when they have to be either withdrawn from, or let down into, the borehole. Each of the plates (S), which are on one end drawn out into a long outward-curved handle, is separately hinged perfectly level to the cap (K) by short screw-bolts (*i*), and provided with a rectangular or triangular cut (*n*) on its straight inner side; these form, when the instrument is closed, a square opening, which corresponds with the thickness of the boring-rods. The plates are kept in close contact during the time of supporting the rods by a strong clasp (*e*), hinged to the top of one of them, and fastened to the other by means of staple and pin. During the process of boring in the beginning of a hole, it is also frequently the custom to keep the forceps closed for the purpose of guiding the rods in their vertical position; in rotatory borings a second, but smaller, forceps, with a round hole, is employed as a guide, it being attached to the top of the supporting forceps, and opened when the latter is in use.

10,708–9 THE SLIDING-JOINT (XV. and XXXIV.; Drawing III.); Plate XI., figs. 11 and 12.

This instrument was invented and employed with great success by Messrs. Kind and Oeynhausen, to avoid the danger, in deep borings by percussive motion, from the concussive action of the rods, producing their jamming, bending, or entire breakage. It consists of two parts, made to slide one upon the other for a distance of about 10 inches to 14 inches, and fixed

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10,708 10,709 continued. with their ends between two rods, by means of screw and collar, about 200 feet to 300 feet above the boring tool, by which construction and position the portion of the boring-train below the sliding-joint is made independent of the one above, so that it has not to carry the weight of the latter, which, on the contrary, draws upwards the entire lower portion, weighing from 12 cwt. to 16 cwt. or more. The upper portion of the rods remains always suspended from the lever, and is perfectly balanced by a counter weight above the stage, which thus reduces its weight to zero, whilst the detached boring portion below, after being raised the required full stroke, drops down and acts alone, followed by the balanced upper part, which gently descends through the same height of stroke till it rests upon the bottom of the slot. The balanced portion is usually composed of Kind's or Degousée's wooden boring-rods, and therefore extremely light, although durable; but if its rods are also made of iron, their dimensions are generally smaller than they would be if in connexion with the falling portion of the rods, which, on the other hand, must be made larger than usual to produce the greatest mechanical effect. The older forms of the sliding-joints are flat and fork-shaped, having the slot in the sliding-rod below, whilst the fork is provided with a corresponding cross-bolt passing through the slot, as seen in the models and plates, &c.; but recently they are often made with a cylindrical slot-casing, and a square, collared sliding-rod for the falling portion of the rods.

Model XXXIV., Drawing III., and Plate XI., fig. 8, represents the lower part of a sliding-joint exclusively employed in the boring process, and in this instance directly attached to the end (C) of the main rod (Y), which thus is either flattened out and provided with a slot, whilst figs. 11, *a*, represent a sliding-joint connected with a main rod (fig. 14*a*) by the usual socket-joint immediately above the round neck (Y^1) for the reception of the spring-guide (fig. 13); E is the forked upper part and F the lower portion of the sliding-joint, through the slot of which the corresponding cross-bolt of the fork passes.

Model XV., Drawing III., and Plate XI., figs. 12, *a*, is a sliding-joint of a slighter make, it being only used for cleaning purposes, when it is directly attached to the mud-pump; L is the fork attached to the rope or slight iron rods, and H the lower part containing the slot, which, however, is longer than that in sliding-joints for heavy borings, and in many cases is placed the reverse way.

15,017 KIND'S WOODEN BORING-RODS (also *see* Model 5,841; Drawing IV., No. 18,882); Plate VIII., fig. 18.

These boring-rods of wood, with iron joints and sockets, were invented and first introduced by Mr. Kind, a well-known boring-master in Germany, and are now commonly employed with great success in deep borings, where, on account of their extreme lightness—a wooden rod, 28 feet long, is lighter by

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15,017 two-thirds than an iron rod of the same length and proportional section—
continued their substitution for the iron rods in the balanced portion of the boring-train above the sliding-joint is of great importance. The model, which is made on a scale = $1\frac{3}{4}$ inch to 1 foot, represents a complete rod at full length, with a section of the joint and socket at one end. In the model of the hydrostatic fallborer, No. 5,841, a set of wooden rods is also employed, the sections and views of which, according to the same scale, are delineated on the Drawing IV., Museum No. 18,882. These rods are uniform, each consisting of a shaft (R) $2\frac{1}{2}$ inches to 3 inches in diameter, made of one piece of round, sound, grown timber, of about 24 feet in length, joined with both of its ends by means of slit and wedge (W) to slightly conical tubes (S) of strong sheet-iron, 3 feet to 4 feet in length, each of which being securely fixed to a corresponding solid neck (H) of an octagonal iron socket-head, containing a female screw, by means of two round iron cross-bolts. Every pair of wooden rods, thus constructed, is coupled by a short wrought-iron middle piece (*m*), which is provided at both of its ends with a socket and male screw, corresponding with the female top in the octagonal sockets (V) of the rods.

Another kind of wooden boring-rod, resembling in many respects the rods described above, is employed by Degousée, and represented in Plate XI., fig. 7. The ends of the wooden portion of the rods are fixed by tongue and fork (*e*), the latter forming part of a solid collar which is connected with the respective screw-socket by a short, thin, square neck, whilst the whole fork-joint is capped by a corresponding iron tube (A), and fixed by means of three cross-bolts, the tube being slightly drawn in at one end, so as to fit the neck, and separately keyed (reverse to the bolts) to the collar of the joint. The rods are joined directly together by their male and female sockets, thus leaving out the middle piece employed by Kind. They are also provided with two or three iron rings, fitted and riveted at equal distances around their wooden portion to prevent the wood from splitting, either in consequence of heavy concussions, or of too long exposure in the water. The sockets have key-faces similar to those described in fig. 4.

Whole length from joint to joint, 21 feet to 28 feet; section of wooden rod, $2\frac{1}{2}$ inches to 3 inches; length of tongue, 9 inches to 12 inches; diameter of sockets, $2\frac{1}{4}$ inches to $2\frac{1}{2}$ inches; neck, = $1\frac{1}{2}$ inches to $1\frac{3}{4}$ inches square; length of tubular cap covering the joint, 12 inches to 15 inches.

12,084 HYDROSTATIC FALLBORER, for Boring Deep and Wet Holes. Scale: $1\frac{3}{4}''$ to $1'$. (No. 5,841, old Model; No. 18,879, Drawing I.); Plate XV., figs. 16, *a*, *b*.

The objects of this boring apparatus, as seen in the working model and the two accompanying sketches, as well as in our Plate XV., fig. 16, are to

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12,084 continued. avoid, in deep and wet borings, the use of costly and heavy iron rods, and also to prevent the frequent accidents occurring from breakage when the whole set of joined and armed iron rods are in the usual direct connexion with the boring tool, and therefore allowed to have a free fall along with the borer at each stroke. In holes of considerable depth, often months were wasted in attempts at drawing out broken and bent pieces of iron rods, and before the regular work of boring could be resumed; these accidents forming a great part of the cost of many borings. The hydrostatic fallborer is an immense improvement on the sliding-joint, which hitherto has been the only instrument known and employed to avert in some degree the accidents referred to. Both work on the same principle, but the hydrostatic fallborer can be worked with greater facility and efficiency than the sliding-joint, which at present is almost exclusively employed for cleaning purposes.

This borer can only be applied in wet and lined holes of not less than 200 feet in depth, with a diameter of from 9 inches to 12 inches, the hole being kept constantly filled with water to a depth of at least 75 feet. The hydrostatic fallborer acts from the alternating resistance of a column of water, either upon the piston-shaped regulator or parachute O (A), in the up-stroke movement of the working or lifting-rods, or underneath the regulator in their downwards stroke. During the up-stroke the movement of the regulator (A) closes the attached shears on the head of the boring tool, which it thus raises, whilst the down stroke produces an opposite upward movement of the regulator, with the contrary effect of opening the shears, which thus drops the borer. The upper portion of the boring train, which serves only to raise the borer the full height of the stroke, and to which the shears are attached, containing the mechanism of the apparatus for producing the free-falling action of the borer and its gear, consists of wooden boring-rods (*see* No. 15,017, and Plate VIII., fig. 18), coupled in sets of three to a length of 90 feet, the whole being suspended from a lever above the surface and balanced by a counter-weight in the usual manner, as described in the description of the sliding-joint (No. 10,708–9). By the aid of a swivel (*see* Model No. 10,745, and Plate IX., figs. 12, 13) the length of the upper rods is regulated in proportion to the advance of the borer, whilst the whole boring train is turned by means of the wooden horizontal lever or handle passed through an eye in the head-joint of the rods, which is made to turn in the universal-joint below the swivel (*see* Plate IX., figs. 12, 13). The model is worked by a crank-gear similar to those adopted for working pumps, not only for convenience, but principally to avoid injury to the model, which would follow from incautious treatment, if the rods were to be worked by a cam-gear and balance-bob. The description attached to the model coincides with the crank arrangement. The stroke is $2\frac{1}{2}$ feet to 3 feet, and consequently the fall of the borer in accordance with it.

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12,084 continued. The weight of the boring tool and gear ranges from 5 cwt. to 15 cwt., depending entirely on the nature of the rock to be pierced, and on the width and depth of the hole.

Referring to the model and sketches, the mode of operation is as follows:—Suppose the whole of the balanced upper portion of rods raised by means of water, horse, steam or hand-power, in connexion with a lever and its gear, to the full height of the given stroke, carrying with them the fallborer within the closed shears. Arrived at the end of the stroke, and at the point where the direction changes into a downward course by dropping the lever, the water in the hole must press against the lower face of the regulator (O), driving it up the space of 3 inches allowed for sliding, but stretching at the same time the two joints (*s*, *s*) which connect the head of the regulating gears (*l*, *t*, O) with the two arms of the shears (*i*, *i*¹), and opening the latter, as seen in sections W on the large Museum Drawing (I), D and F in the sketch on the label, and fig. 16*a* on our Plate XV. In these sections the borer is represented as down the whole length of the slot (*r*) or corresponding stroke, but without touching the bolt which connects the two plates (*a*) of the sheath, and passes through this slot. As soon as the upper balanced rods and their appendages have travelled downwards the whole length of the stroke, and the hooks of the shears have passed the spearhead-shaped top (V) of the uppermost of the iron rods (*b*) containing the slot (*r*), and attached to the fallborer, in accordance with the adjustments of the swivel—the retrograde or upward motion of the balanced portion of the rods begins immediately, by which change the water column above the regulator (O) presses it down the given stroke of 3 inches, spreading thereby the two connecting-joints (*s*, *s*), which causes the hooks at the lower end of the shears to be brought into close contact with the spear-shaped head (V) at the flat end of the lower or percussive-acting portion of the whole boring-train. In raising now the balanced rods, and with them the attached sheath or casing (*a*), up to the highest point of the stroke, the shears will, in their then closed position (in consequence of the continued, steady downwards pressure of the water on the top of the regulator) carry the borer with them up to the same height, provided the weight of the water column above the regulator is always in proportion to the weight of the full-armed fallborer.

The sections A, B, on the label, fig. 16*b*, Plate XV., and Y on the illustrative Museum Drawing I., show the borer when caught and raised, and at the point of being relieved from the clutches of the hooks of the shears by the change of the up-stroke into the downward movement, as described above.

To disengage the shears from the borer is the work of a moment; the slightest jerk produced by the retrograde downward pressure of the regulator upon the water column below is sufficient to ensure this action. The rest of

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12,084 (continued) the down-stroke the water column has only to bear the insignificant weight and pressure of the regulating gear, whilst during the up-stroke the water column above the regulator has to balance the additional weight of the armed borer throughout the full given height from which the borer has to fall down.

Both of the hooks at the lower end of the shears, as well as the spear-shaped head of the sliding part (*b*) of the main boring-rod (b^1, *d*), are provided with slightly obtuse angles to ensure an easy slip and discharge of the suspended borer.

The accompanying Plate (XV.) represents three vertical sections and elevations of the fallborer within a lined or tubed borehole; its construction being according to the latest improvements, and corresponding exactly with the form exhibited in the working model in the Museum. Fig. 16 is a vertical section through the axis of the main body of the apparatus, and at right angles to the plates (*a*) forming the sheath. These plates (*a*, a^1) are of wrought-iron, and wedged in a parallel position by four sets of wedge-keys to the flat head (*p*) of the square iron head-rod of the balanced portion of the boring-train, whilst their lower ends are securely kept apart by means of a strong key, and their middle part principally by two cylindrical blocks fixed by screw bolts. (O) is the regulator or parachute, fitted exactly, and concentric with, but loose over, the square neck of the flat head (*p*) of the balanced rods, so as to slide up and down a certain distance. It is composed of leather, capped above and below by two iron discs, and the whole screwed together and attached, by the same screw-bolts, to the cheeks (*t*) at the head of the two sliding-bars, which are in close contact with the square neck of the rod, and made to slide within corresponding vertical grooves in the middle and on the inner faces of the wedged heads of the sheath-plates (*a*, a^1). (*c*) is a short key passing through the square neck of the rod above the regulator (O) to prevent the latter from rising higher than the given stroke, the down-stroke being regulated by the cheeks (*t*) resting on the rectangular head of the sheath-plates. (*l*) is a short square shaft, to the upper end of which the two sliding-bars are riveted, whilst its head is connected with the shear-arms (*i*, i^1) by means of short joints (*s*, s^1), both arms being hinged separately within the sheath by screw-bolts. (*b*) is the upper rod of the falling portion of the apparatus, and fixed to the main rod (*d*, b^1) by a wedge socket-joint; its upper part is drawn out flat, so as to fit exactly into the sheath ending in a spear-shaped head (V), which corresponds with the hooks of the shears (*i*, i^1). (*r*) is the long slot cut into the middle of the flat part of this rod, by which it is made to slide up and down on the key passing through the lower end of the sheath. The sides of this rod, immediately below the spear-head, are also provided with guide-plates, fixed by dovetail and screw and overlapping the sides of the sheath, for the purpose of keeping the main rod and the attached borer in a vertical position.

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12,084 continued. (*d*) is the round upper portion of the main rod (b^1) on which the spring guide (*see* Plate XI., figs. 13, *b*) is sliding up and down.

Fig. 16*a* is a front elevation and partial sectional view of the apparatus, with one of the sheath-plates (*a*) removed, showing (like the section, fig. 16) the position of the regulator, the shears and the borer at the commencement of the down-stroke, where the borer is down and the shears open; whilst fig. 16*b* is a similar elevation, but with only part of the sheath laid open, representing the regulator, shears and borer near the end of the up-stroke, where the regulator is down and the borer consequently raised and suspended by the closed shears. (*n*) is the chisel, provided with cross blades for widening the hole (described with the other chisels in No. 10,729–30, &c.).

10,703 FALL-HOOD or PARACHUTE (VII., Drawing III.); Plate XI., figs. 9, 9*a*.

This model represents a safeguard invented to prevent the rods from falling down the borehole, one behind the other, if broken or disjointed by accident. The instrument, which often saves the borehole and the whole boring gear from being damaged or totally destroyed, has some resemblance to the piston of a pump; its leather disc, which has a diameter of only 1 inch less than that of the borehole, compresses the water during the lowering or the sudden fall of the rods, on account of the little space left for the escape of the water between the periphery of the disc and the borehole. A slow descent of the rod is thus insured.

The fall-hood is provided in the centre of its cylindrical wooden block (H) with a tubular shaft or angle, by means of which it slides up and down between the two collars on the rod (*e*) the full length of the stroke of the borer during the process of boring. Experiments have shown, that when a fall-hood was attached to a long train of heavy rods, the latter descended, during a fall from a height of about 40 feet, at such a slow rate that any part of it could be easily caught by the common key. (No. 10,719–21.)

Dimensions.—Length of shaft from socket to socket, 4 feet to 6 feet; playroom for cylinder, 2 feet to 3 feet; diameter of wooden cylinder, 9 inches to 10 inches; diameter of leather disc, 10 inches to 11 inches; height of cylinder, $1\frac{1}{4}$ foot to $1\frac{1}{2}$ foot; diameter of solid shaft, $1\frac{1}{2}$ inch.

10,704 FALL-HOOD or PARACHUTE, represented in XXI., and Plate XI., figs. 10, 10*a*.

This instrument is worked on the same principle as the one above described, but is of a construction which prevents it from becoming jammed, as no matter can accumulate on the bell-shaped and elastic top of its hood. The latter is made of leather, and fixed by means of straps and rings to its tubular metal shaft, which can slide up and down a given height on the

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10,704 upper part of the main rod, but below the sliding-joint. The outer side of the leather hood is armed with narrow metal straps, which project several inches beyond the lower edge of the hood, and serve as a protection against wear and tear. Each of the Plates represents a full side view, with a partial vertical section and a top view.

Dimensions.—Length of shaft from socket to socket, 4 feet to 6 feet; playroom for the tubular shaft (2¼ inches to 2½ inches in length) of the parachute, 18 inches to 2 feet; height of leather hood, 12 inches; largest diameter of leather hood, 9 inches to 12 inches; diameter of solid shaft, 1½ inch.

II. *b.*—ROTATORY BORING INSTRUMENTS.

10,726 THE OPEN SHELL-AUGER (L, Drawing IV.): Plate XIII., figs. 3, 6, 11.

This model (and fig. 3, Plate XIII.) represents the form of an auger usually employed for boring by rotatory motion through clayey or other cohesive material. The shell or mantle is made of strong sheet-iron, circularly bent round to the extent which leaves about one-third of its supposed full periphery open, forming thus two vertical sharpened and steeled edges, whilst its bottom is formed by a sloping, flat, and partly projecting tongue on the left side, and a short slightly upward-turned heel, for the support of the bored material, on the right side. Both of these inclined bottom-blades are generally cut out of one piece of plate, and welded to the oblique bottom edge of the mantle at their respective angles. The neck or shaft, which is round, and usually provided with a male screw-socket for being joined to a corresponding female socket of the boring-rod, is either welded or riveted to the shoulder of the shell-mantle, and bent into a central position. Fig. 3*a* is a horizontal section through the middle of the shell, showing the shape of its bottom-blades. Augers of this construction are employed for boring holes from 6 to 12 inches and more in diameter.

Dimensions of Model.—Diameter, 6 inches; height of cylinder, including bottom-blades, 2 feet 3 inches; length of shaft, 1 foot 4 inches; weight, from 30 to 40 lbs.

Two other forms of open augers, especially employed for boring narrow holes, from 3 inches up to 8 inches in diameter, are represented in figs. 6*a* and 11 of same Plate. The first is an auger of about 4 inches diameter, by a mantle length of 18 to 20 inches, especially adapted for penetrating ground of a stiff and clayey nature; its lateral opening is generally made wider

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10,726 continued (about three-eighths of its periphery) than is usual in augers employed to work through soft and disintegrated ground. The tongue and heel are part of the mantle, and formed by its gradual contraction towards the centre, the heel being short and less inclined. The upper edge of the mantle is cut obliquely, and the shape and figure of the shaft as usual. Fig. 11 is an auger differing from the former by being nearly three-fourths closed, and provided with a gimlet-shaped head, which form not only penetrates the ground easily, but is also well adapted for boring narrow holes through clayey gravels and sands, the loosened material being perfectly retained within the shell. The whole length of the auger is about 2 feet 9 inches, and the diameter of the shell $3\frac{1}{2}$ inches.

10,725 CYLINDRICAL SHELL-AUGER (P, Drawing IV.); Plate XIII., figs. 4, 4*a*.

This auger is preferred to the open form for working readily through dry but incoherent ground. The tongue and heel are of the same description as those in the auger of fig. 6, except that the heel is larger and bent inwards at a right angle, affording thus an efficient point of support for retaining the loosest bored material accumulated within the cylinder until brought up to the surface. The lower part of the cylinder, immediately above the heel, is obliquely cut out a few inches in height, and flush with the latter and the front edge of the tongue; its upper edge is also oblique, and strengthened by the flattened half-moon-shaped head of the shaft, which is riveted to the highest part on the inner side of the cylinder. Diameter of cylinder, 6 inches; whole length of shell (including screw-joint and tongue), 3 feet; average length of cylinder, 18 inches; length of shaft, 12 inches to 14 inches.—(Sketch, medium scale.)

10,727 CYLINDRICAL SHELL-AUGER, WITH CLACKS (U, Drawing IV.); Plate XIII., figs. 5, 5*a*.

This auger is only used for boring imperfectly coherent drift and running sands, for which purpose it is provided with two sets of common "butterfly-clacks," fixed respectively near the top and bottom of its cylinder, in order to prevent the loosened materials (cut out and guided into the respective divisions, in the middle of the cylinder and above the upper clack, by means of a spiral tongue) from falling back into the hole during the withdrawal of the auger. Size and shape of the shaft, and the method of its fixture to the horizontal edge of the cylinder, is similar to that of the plain closed shell-auger.

Dimensions of Model.—Height of cylinder, 2 feet; diameter (inner) of same, 7 inches; length of shaft, 18 inches; height of spiral tongue, 8 inches. —(Sketch, medium scale.)

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10,750 TRIANGULAR SHELL (M, Drawing IV.); Plate XIII., fig. 13.

This boring tool is generally used to widen a borehole in clayey, sandy, and gravelly strata, after the use of a similar but narrower borer (*see* Plate XIII., fig. 16, and N, Drawing IV.) for breaking the ground. It is made of an isosceles-triangular plate of wrought-iron, about 1½ inch thick, 15 inches high, by a base of 8 inches, the slanting sides of which are forged into alternately curved cutting edges and steeled, running out into a spiral gimlet-shaped head, and S-shaped in the horizontal section through the middle of the blade. The shaft, which is square, straight, and provided with the tongue of a fork-joint, is welded at right angles to the horizontal base of the blade, and coinciding with the axis of the same. Full length of borer from head to joint, 2 feet 8 inches.

Another kind of shell frequently employed in rotatory borings through clay and very compact marls is the one represented in figs. 7, 7*a*, Plate XIII. It consists of a long, narrow, oblong blade, which is strengthened in the middle by a circular swelling in the direction of its axle, and provided with alternately inclined side-cutting edges, forged similarly to those of the preceding borer, as seen in the cross-section (7*a*). The head of the blade runs out into a central, narrow guiding-point, projecting only a few inches beyond the two horizontal cutting edges thus formed, which are sharpened in an alternate direction; the square, and centrally-placed, shaft forms one piece with the blade, running gradually out into the latter, and provided with the usual male screw-socket. Whole length of tool from head to screw, 3 feet; width of blade, 5 inches; diameter of central part, 2 inches; length of blade, 18 inches; section of shaft, 1½ inch square.

10,749 SAND-FUNNEL or DIVER (J, Drawing IV.); Plate XIII., figs. 16, 16*a*.

This instrument is generally employed in cleansing a borehole, which passes through drift sand or layers of shingle, &c. It consists of a sheet-iron funnel fixed tightly over a square iron shaft, which projects about 8 inches beyond its junction with the funnel point, ending in a gimlet-shaped auger to perforate the ground.

The shaft is supported by passing through the middle of a transverse bar, fixed inside near the circular top-edge of the funnel, the diameter of which is usually about one-sixth less than the width of the unlined borehole.

Largest diameter of funnel, 9 inches; depth of funnel, 11 inches; shaft, 1 inch square; whole length of tool, 2 feet 8 inches.

10,738 THE SACK-BORER (Q, Drawing IV.); Plate XIII., fig. 15.

The use of this tool is to clear a damaged borehole from the accumulated gravel, shingle, &c., underneath the pipes, either in the centre or around

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10,738 continued. the sides, so as to enable pipes to be forced farther down, or through the drift, or damaged widened part. It consists of a long square iron shaft, provided, about 6 inches above its pointed end, with an ear-shaped hoop of iron, to which a strong canvas bag is sewed by a thin well-tempered wire; the upper end of the shaft is fitted to the boring-rods by means of a wedge-shaped fork-joint. Length of shaft, 3 feet 8 inches; width of hoop, or mouth of bag, 5 inches to 6 inches; height of hoop, 15 inches; depth of bag, 12 inches to 18 inches.

10,722
10,748 TWO CLAY CUTTERS (H and I, Drawing IV.); Plate XIII., figs. 10 and 14. Used for boring holes of from 6 inches to 9 inches wide, through stiff, tenacious clay and marls; also for widening holes.

H (fig. 10) consists of two strong, steeled blades of a trapeziform section, which are curved and joined in a way to present a half-moon shape in a side view; the junction of the ends in front form vertical edges in one line parallel with the axis of the shaft; whilst in a front view the two joined blades curve elliptically, leaving an ovate aperture between them for the passage of the loosened materials. The cutting edges face so that the tool can be worked right and left, and for the same reason the shaft and rods are coupled by means of either a flat or round fork-joint. This tool cuts through the toughest clay without jamming, whilst the bored matter loosened by it is afterwards removed by another tool especially constructed for that purpose. Shaft, $1\frac{1}{2}$ inch square; diameter of joint, $2\frac{1}{2}$ inches; vertical height of blades, $1\frac{1}{2}$ foot; width, from edge to edge, across the middle, 7 inches.

The *Clay Spoon* (I, fig. 14) is used more frequently than the former in boring through less tenacious clay, or clayey gravel. It is made in the shape of a spoon, with straight back in one line with its shaft, and provided with curved cutting edges running out into a slender pointed head; the horizontal section across the middle of the spoon is semi-lunar. Height of whole tool, 3 feet; shaft, $7\frac{1}{2}$ inches square; width from edge to edge, across the middle of the spoon, $5\frac{1}{2}$ inches; height of spoon, 1 foot 8 inches; depth, $3\frac{1}{2}$ inches.

American Tongue or Snake (twisted) Auger (fig. 8, Plate XIII.). This auger is an auxiliary tool, alternately employed with a corresponding shell-auger for finishing and partially clearing a borehole sunk through sands or sandy marls. It is made of strong sheet-iron twisted into numerous spiral turns, gradually converging to a narrow head, which is split and shaped into two small round blades; the edges of the latter are steeled, as also those of the twisted portion of the tool, which is attached to the rods by means of a broad fork-joint, differing in shape from those represented in figs. 9 and 10. Whole length of auger, including the tongue of the joint, 3 feet.

PERCUSSION TOOLS.

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10,729–30 TWO CHISELS (I. and II., Drawings I. and IV.)—Plate XI., fig. 18—of large dimensions, as generally employed by Kind for deep and wide borings in hard rocks.

They are formed of a square wrought-iron shaft, which is drawn out at one end into a broad flat head, provided with a round cutting edge made of steel, whilst its upper end is forged into a square neck for the reception of the crown-chisel (Z) (described below, No. 10,740, and fig. 19), terminating in a male screw of a corresponding diameter. The difference between the two chisels represented in the models, which are not provided with cross-edges, consists only in the mode of chamfering and hollowing out their heads. In the Plate XI., figs. 18, *a*, *b*, a chisel of similar shape and dimensions, but provided with cross-edges, is represented in several views, of which fig. 18 shows a front elevation of the chisel in connexion with the crown-chisel (Z), and joined to the main rod; fig. 18*a* is a side elevation of the chisel, detached from the crown-chisel and main rod, showing the neck and the cross-cutting edge; and fig. 18*b* a top view.

Dimensions.—Length of chisel, including neck, 2 feet 8 inches; section of shaft, $3\frac{1}{4}$ inches; height of neck, 3 inches; length of square part of shaft, 15 inches; section of neck, $2\frac{1}{2}$ inches square; length of curved cutting edge, 10 inches; height and width of same, 1 inch by 1 inch; width of cross-cutting edge, $3\frac{1}{2}$ inches by 4 inches height; approximate weight of a chisel, 150 lbs. to 200 lbs.

Another kind of large chisel represented in the sketch of the hydrostatic fallborer, Plate XV., fig. 16*b*, and in the model of same, No. 5,841, is of late frequently employed in deep boring. It differs from the above principally by having, instead of the movable crown-chisel, two chisel-blades, of a similar form to those on the latter, permanently attached and welded to the upper end of the octagonal shaft, one placed opposite the other, and both at right angles to the main edge of the boring-head, which is formed of a flat, slightly trapezoidal-shaped steel blade, and provided with short cross-edges, covering in the whole height of the sides. The upper chisel-blades, being principally designed for widening a borehole so as to admit the advancing pipes, are of larger diameter than the bore-head below, or than those used for merely trimming purposes. Its principal dimensions are:—Length (without male screw), 2 feet 9 inches; shaft, $3\frac{1}{2}$ inches square (strongly chamfered); length of shaft (overlapping the head), 2 feet; height of blade, 16 inches; width of main cutting edge of blade, $10\frac{1}{2}$ inches; thickness, 2 inches; upper width of blade, 8 inches; width of side-cutting edges, 4 inches; diameter bored by the upper chisels, $13\frac{1}{2}$ inches.

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10,739 A SMALL CHISEL or TREPAN (E, Drawing IV.); Plate XII., figs. 19, 19*a*. Scale: $1\frac{1}{2}''$ to 1′.

This chisel is used in small and shallow borings through limestones or other moderately hard strata. It is made of a long flat piece of iron, shod with steel, the alternate vertical edges of which are strongly bevelled to correspond with the round, diagonal, and slightly S-shaped cutting edge below. This form not only acts upon a greater surface than a borer of the usual construction, but likewise prevents the borer from being jammed or thrown out of the centre of the hole.

The figure 19*a*, Plate XII., differs from the model by being of smaller dimensions, and provided with a dovetailed tongue to meet the corresponding fork of the succeeding boring-rod described above (Plate VIII., fig. 20), whilst the other is to be attached to the rods by the usual screw socket-joint. The full dimensions represented by the model are as follow:—Length of chisel (including male screw), $2\frac{1}{4}$ feet; section of shaft, $1\frac{3}{4}$ inch square; length of same, 1 foot (including socket); cross-section of blade, $4\frac{1}{2}$ inches by $1\frac{1}{2}$ inch; length of same, 13 inches; diameter of socket, 3 inches; weight of chisel, 50 lbs. to 60 lbs.

To this class of borer belongs the form represented in fig. 11, Plate XII., in which not only the main cutting edge, but also the whole chisel-blade, is forged into the shape of an S, whilst cross-blades are alternately attached to the sides in the direction of the letter-curve, and conform with the periphery of the borehole. This borer is an effective tool, especially in highly inclined or fissured strata, or rocks of varying degrees of hardness, and should always be amongst a complete set of boring tools for boring holes from 5 inches to 9 inches in diameter. Length of borer, 2 feet (excluding screw); shaft, $1\frac{1}{2}$ inches square; blade, $5\frac{1}{2}$ inches wide by 8 inches high; socket, $2\frac{1}{2}$ inches diameter and 6 inches length.

In the accompanying Plate XII. a number of chisels of different forms and sizes according to their applications are represented, of the greater part of which accurate models are in course of preparation.

Fig. 18*a* is an *Ordinary Chisel*, as used for wide and deep borings through very hard rocks. Its head is usually made higher than its greatest width, trapezoidal in shape, and of a uniform thickness of not less than 2 inches. The cutting edge is straight and horizontal, but broken at the corners, and forms a slightly acute angle, whilst the upper part of the head is drawn out in the usual square neck or shaft, with a male screw-socket at the end. A chisel of the usual dimensions drawn, viz., 8 inches largest width, and 2 inches thickness of blade, 2 feet length from edge to screw, $2\frac{1}{2}$ inches diameter socket, and $1\frac{1}{2}$ inch square shaft, weighs from 65 lbs. to 70 lbs.

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Fig. 3 is a *Large Chisel*, with an exchangeable head or blade, to accord with the dimensions and condition of the borehole. It consists of a long heavy rod of not less than 2 inches square in thickness, which is at one end provided with a male screw-socket of a corresponding diameter, whilst the other end is forged into a broad head, and provided with a rectangular slit for the reception of a corresponding chisel-blade, which is fixed by means of two screw-bolts passing through the fork-joint. The blades are formed of a high piece of steel plate of an uniform thickness ($1\frac{1}{4}$ to $1\frac{1}{2}$ inch), and of a width at the cutting edge varying from 12 inches down to $4\frac{1}{2}$ or 5 inches, or about $\frac{1}{2}$ inch or 1 inch wider than the forked rod-head; they are regularly drawn in on both sides into a trapezoidal shape, in a proportion of 1 inch to a height of 9 inches, terminating in an angular top with partly chamfered edges. The cutting edge of each of these chisel-blades is either single or triple-edged, but in all cases straight and horizontal. One form of the latter kind is represented in the Plate, in which the chisel-blade is furnished with a centre edge, which is about one-half of its width, and projecting only a few inches beyond the main edge, dividing thus the action of the chisel on the rock by breaking the ground easily in boring two widths at once. In employing a chisel of the above description, one great advantage is that, in case of sharpening or of any breakage of the chisel-head, it is only necessary to detach the blade, which weighs only about 50 lbs. to 60 lbs., and send it alone to the forge, carried and mended by only one man, whilst the heavy rod, weighing from 4 to 5 cwt., is always left behind at the mouth of the borehole, if not also required to be repaired.

Figs. 4, 4*a* represent a *Triple-edged Chisel*, with a long projecting centre blade, which is fitted by means of forks and screws to an ordinary chisel, either direct to the middle of its horizontal unbroken cutting edge, or into a corresponding cutting in the middle of the latter, instead of being forged in one piece with the main blade, as in the chisels of figs. 3, 5, and 13. A chisel of the above form has been frequently employed in holes of a large diameter, and is generally considered to be a most convenient and highly efficient tool for sinking through all kinds of rocks, on account of its long exchangeable centre blade.

Fig. 13 is a *Triple-edged Chisel* of an ordinary construction, as used in narrow borings through hard rock, the projecting centre blade, main blade, and shaft being forged in one piece; the usual male screw-socket is frequently replaced by a broad dovetailed tongue of a fork-joint, as represented in the figure.

Figs. 5, 5*a*, 5*b*.—A *Triple-edged Chisel*, similar to that of fig. 13, but of larger dimensions, and provided with inward curved wing blades, forged to both of its sides for the purpose of trimming the wall of the borehole simultaneously with the progress of the latter. The wing blades commence immediately above the horizontal cutting edges at both sides of the centre blade.

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Figs. 6, 6*a*, 6*b*.—An *Ordinary Chisel* provided with a broad curved wing blade at only one of its sides, the edge of which lies in one plane with the horizontal cutting edge of the chisel. It is frequently employed with good effect in sinking through broken ground, where an ordinary chisel would be constantly subjected to jamming, &c., and also for centring and trimming holes.

Fig. 15 is an *Ordinary Chisel* with a single straight cutting edge, as employed in narrow borings. It is joined to the rods by a fork-joint slightly differing from that in fig. 13. With a width of 3 inches to 4 inches at the cutting edge, 1½ inch average thickness of blade, 1½ inch square shaft, and a total length of 2 feet, the weight of such a chisel is from 20 lbs. to 30 lbs.

Fig. 8 is a *Triple-edged Chisel*, in which the three cutting edges are reversely arranged, compared with those of the chisel represented in figs 3, 4, and 13, whilst the upper part of the head, the shaft, and socket, are of the ordinary forms. It is employed alternately with an exactly corresponding triple-edged chisel of the other order (fig. 13), which generally proceeds to a depth not much exceeding the height of its projecting middle blade, whilst the other trims down the annular portion left by it, and frequently is allowed to proceed farther, so as to leave a core, which then is worked down in turn by applying the first chisel again, and so on. A chisel of this description, with a length of 2 feet 3 inches, 6 inches width of main blade, 2 inches projection of side blades, 2½ inches width of middle edge, 1½ inch square section of shaft, 2½ inches diameter of socket, and about 18 inches length of shaft, including socket, weighs about 40 lbs. to 50 lbs.

Fig. 7 is a *Square-headed Chisel*, provided with a horizontal cross-edge, and employed either for breaking the ground through certain kinds of rocks, or for trimming and centring the bottom of a borehole. Another form differs from this chisel by having four inclined cross-edges, formed by a pyramidal head, similar to that of fig. 20.

10,743 THE PYRAMIDAL BORER (D, Drawing IV.); Plate XII., fig. 20.

This tool is principally used to break through a thin hard layer of ferruginous or conglomerated rock, when a common chisel is not sufficiently strong for the purpose. Its head is formed of a square and slender pyramidal block, with steeled head and edges, the four sides of which taper gradually, with an outward curve from the base to the point; the round or square shaft being either screwed or welded to the centre of the square base, and fixed to the rods by a screw socket-joint. Length of tool, 2 feet; base of head, 5 inches square; shaft, 1½ inch square; head, 10 inches high; weight, about 40 lbs. The sketch is of one of smaller dimensions.

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10,735 CROWN or CROSS-BORER (C, Drawing IV.); Plate XII., fig. 14.

Used generally after the pyramidal borer; it is better than a common chisel for trimming and centring a borehole, as well as for working through tough deposits of mixed sand, clay, and small fragments of rock. Its head is formed of a solid bell or dome-shaped block, the base of which is forged into four horizontal cutting edges in the shape of a cross, by means of four vertical triangular indentations of equal depth and at equal distances around the mantle.

Height of head, 10 inches; length of whole tool, 2 feet; radial length of cross-edges, $3\frac{1}{2}$ inches; shaft, $1\frac{1}{2}$ inch square. Fig. 14 represents a smaller tool with round shaft.

Another kind of crown-borer, as employed in the "Chinese method of boring with the rope," is represented in Plate XII., fig 2.

The use of the rope instead of rods in earth-boring has hitherto found little favor with European borers, although it has been worked extensively and successfully for centuries by different nations on the eastern portion of the Asiatic continent. After many failures, it is coming now into some use in France and Germany.

The apparatus required for rope-borings consists of the borers, the boring-rod and guides, the mud-pump, the boring-stage, the ropes, and some auxiliary implements. The borers are either ordinary chisels (single or triple-edged), cross-borers, or crown-borers; all of which have a stout square shaft tapering upwards, which is strongly chamfered and provided with a male socket-screw. The head of the latter borer, represented in Plate XII., fig. 2, is furnished with two vertical blades, which cross one another at right angles, and provided with semicircular cutting edges; whilst each of the four angles thus formed by the blades are also fitted with one or two small horizontal and less projecting cutting-edges. The shaft is generally of wrought-iron, but the blades and edges of steel, or steeled. For the introduction of tubes into the hole, and to prevent jamming and excessive wear of the borer, it is necessary to bore the hole perfectly perpendicular, which would not be possible if the borer were attached directly to the rope, and had an unsteady motion. A long iron guiding-rod, of the size and shape represented in Plate XII., fig. 1, is placed between the borer and the rope-end. This rod is generally made of $2\frac{1}{2}$ to 3-inch square and strongly chamfered wrought-iron, about 6 to 7 feet in length, and provided near its upper end with an iron muff, of a diameter $\frac{1}{4}$ inch less than that of the borehole, and about 9 to 10 inches in length. The head of the rod is forged into a female screw-socket, of a size exactly corresponding to the muff above, whilst the upper end of the rod, about 6 to 9 inches above the muff, forms a large eye, to which the boring-rope is fixed. The socket and muff serve to guide the borer, and are provided with two to four vertical, semicircular flutes, for the purpose of facilitating the passage of

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the bore-mud, and thus to reduce the resistance of the latter against the armed borer. With a diameter of 4 inches for the muff, the flutes are generally made 1 inch wide, and $\frac{3}{4}$ inch deep; and, with a diameter of 7 inches, from 2 to $2\frac{1}{2}$ inches wide, by a depth of 2 inches. In boreholes from 8 to 18 inches diameter, the muffs are replaced by perforated or wheel-shaped iron discs; the lower one of which is very frequently provided with high and projecting chisel-blades, radially fitted to its under-side, so as to serve the double purpose of a borer and guide. The whole weight of a borer and armed rod for a hole of 18 inches diameter seldom exceeds 800 to 1,000 lbs.

The spoon or mud-pump, for cleansing a hole bored with the rope, is of the same description as that employed in ordinary boring, and is only 1 to 2 inches less in diameter than the borehole.

The surface apparatus employed in rope-borings consists of the usual tower and boring-stage in connexion with the lever and winding gear similar to some of those described above.

A lever arrangement, frequently employed and of the simplest kind consists of a broad (wooden or iron) disc of about 18 inches to 2 feet in diameter, which turns on horizontal axles, and is worked by a lever-beam fixed to one of a series of square corresponding tenon-holes on one side of its periphery; the rope is laid over a groove adjoining these holes, and fixed, after being sufficiently stretched, by means of a clamp and screw to one side of the disc, whilst the remaining portion of the rope is kept slack, and partly wound over a windlass beyond the end of the long lever-arm, so that, when boring has ceased, the withdrawal of the borer can be effected by the windlass and the same rope as soon as the latter is released from the clamp, the disc serving as a pulley after the removal of the lever-bar. The spring for recoiling the lever consists merely of a spring-pole fixed horizontally underneath the ground-frame of the boring-stage, and connected with the end of the lever by means of a leather strap; the length of the boring-rope is regulated by the clamp from time to time in proportion to its increased stretch, and to the advance of the borer. With such an apparatus, and a disc of $3\frac{1}{2}$ feet diameter, a lever-beam of 9 feet long, three men can work a borer of 800 lbs. weight. The maximum of the lift would be about 1 foot, and the number of lifts $=$ 1,200 per hour, if every ten minutes the men make a spell of five minutes. With a windlass barrel $=$ 10 inches, driving-wheel and pinion $=$ 30 inches and $4\frac{1}{2}$ inches diameter, and a handle height of 15 inches, it requires eighteen minutes' time for winding up a borer from a depth of 100 feet; for lowering the same, only 9 to 10 minutes. The lighter mud-pump can be easily raised in nine minutes.

The ropes used in these borings are made of the best hemp, and about 1 to $1\frac{1}{2}$ inch in diameter. To protect them against wear, they are frequently enclosed with leather, or tow and tarred string, tightly wound round; or

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wooden cylindrical blocks attached to the rope at intervals of 3 to 6 feet; but many boring masters prefer to bore with the free and unencumbered rope, as no great advantage seems to result from the adoption of these auxiliary contrivances, considering the cheapness and durability of the ropes. Wire ropes have been only recently employed; but with them the rotatory action of the borer has to be principally produced by manual labor, whilst, when the hemp ropes are used, the rotation is greatly assisted, if not mainly produced, by the twisting action of the rope.

Amongst the auxiliary instruments employed in rope-borings, is the cylindrical guide-block which serves to preserve the vertical position of the rope within the surface-pipe; it is cut into two semicircular parts, and provided with a 2-inch bore, funnel-shaped towards both ends. The boring-shears, or forceps on top of surface-pipe, &c., the different kinds of keys and many of the instruments usually adopted in the rod-boring system, are also used.

The works, preparatory to boring with the rope, are the sinking of a shaft, in which the guide-tube is carefully erected and fixed, or a series of joined surface-pipes, serving as a guide, are sunk directly from the surface of the ground down to the solid rock. The process of boring forms two divisions:—

(1st.) The *lowering* of the borer by means of the windlass and brake, and stretching of the rope and regulation of the stroke after the borer has reached the bottom of the hole. The boring itself is made by the alternate raising and dropping of the borer, rotating it if the twisting action of the rope should not be sufficient. The rope and borer are withdrawn from three to four times per shift boring through sandstone with a depth not exceeding 150 feet, after the tension of the rope is marked at a point of the latter coinciding with a mark made on the disc or drum.

(2nd.) The *cleansing of the borehole* by lowering, working, and withdrawing a mud-pump of the usual construction. The impediments against the steady progress of the rope-borer are generally of a less serious nature than those occurring in the rod system, and principally due to the following accidents:— 1st, tearing of the boring-rope; 2nd, breakage of the borer, the guide-rod, or the mud-pump, or the separation of portions of the borer and other pieces in the hole, in consequence of careless fixing; 3rd, extraction of objects which have fallen into the hole; 4th, jamming of tools; and 5th, the caving-in of portions of the hole.

All the tools required to remove any of these evils must be of such construction that their application is independent of any pressure from above; ropes, swivels, bolts, keys, and screws, steeled edges of chisel-blades, as well as the single blades composing a crown-borer, are the principal parts of a boring-gear especially liable to breakage or separation, and for the extraction of which different forms of hooks, forceps, shears, spoons, &c., are employed, similar to those adopted in rod-borings.

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With respect to the method of lining a hole bored by the rope, and the instruments for lowering, fixing, or raising the tubes, there is little difference between the two systems of boring. To prevent the loss of cutting-blades, screws, or keys, &c., accidentally detached from the main body of the borer, these portions are frequently fastened by means of leather-straps or chains without interfering with the action of the borer. In the mining district of Saarbrück, in Prussia, extensive borings with the rope have been lately executed; one hole, for instance, was bored to a depth of 150 feet through the new red sandstone, and another hole through 80 feet of sandstone and 120 feet of coal measures; both bores were $4\frac{1}{2}$ inches in diameter. Another was bored to a depth of nearly 100 feet, with a diameter of 18 inches, and several others to depths ranging from 250 to 300 feet, and a diameter of 7 inches.

With respect to the time required for boring a 7-inch hole to a depth of 230 feet, careful observations have led to the following results:—

1. Lowering of borer required	... .	1 minute
2. Regulating and stretching the rope	... ...	4 ,,
3. Boring of 2 feet in seven starts, each of 10 minutes' work, 5 minutes' rest, and 1,491 lifts at $2\frac{1}{2}$ feet	..	105 ,,
4. Winding-up of borer	.. ..	15 ,,
5. Cleansing of hole	... ...	30 ,,
Thus, for boring 2 feet	... ...	155 minutes

or a little more than two hours and a half; and according to which, if no accidents interrupted the regular work, 9 inches per hour have been bored on the average through sandstone and rocks of similar hardness; through conglomerates at a great depth, only 3 inches per hour; so that, for the whole depth of 300 feet, the borer advanced about 6 inches per hour on the average.

In another 7-inch hole of 266 feet depth, through sandstone, 6 feet 2 inches were bored in twelve hours, viz.:—

The 1st 100 feet in 103 hours, or 1 hour = 1 foot
The 2nd 100 ,, in 187 .. or 1 .. = $6\frac{1}{2}$ inches
The 3rd 66 ,, in 233 .. or 1 .. = $3\frac{1}{2}$,,

In a well-arranged boring apparatus and gear the borer makes from twenty to twenty-two lifts during one revolution, or $2\frac{1}{2}$ inches around the periphery of an 18-inch bore. The stretch of an old 225 feet long hemp-rope amounted to about 10 inches.

IV.—CLEANSING, ENLARGING, AND TRIMMING TOOLS.

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10,737 THE MUD-PUMP (XVII., Drawing III.); Plate XI., figs. 15*a*, *b*, and figs. 16, 16*a–c*.

Used for cleansing a borehole. It is a sheet-iron cylinder, 4 to 6 feet in length, open at the top, and about ½ to 1 inch smaller in diameter than the diameter of the hole; so that it may be lowered, raised, or worked without being much subjected to swinging motions, injurious to the wall of the hole. Its bottom is provided with a strong ring, upon which, in some cases, a *bullet-clack* (as shown in figs. 16, *a–c*) is securely fitted. This pump is generally attached to a sliding-joint (fig. 12), and worked either by a train of thin iron rods, or by means of a rope directly attached to its semicircular handle (as seen in fig. 16). It is gently let down upon the bottom of the hole, and then rapidly moved up and down a few strokes, which operation causes the bored matter to pass through the valve into the cylinder until the latter is filled. When raised, the valve is pressed tightly upon its seat, preventing the accumulated matter within the pump from falling back into the hole. Fig. 15 represents an elevation of a mud-pump worked by means of rods in connexion with the sliding-joint (figs. 12, *a*). Fig. 15*a* is a vertical section through the axis of fig. 15, showing the position of the clack-valve (T) and the mode of fixing the neck to the cylinder and to the rod. Fig. 15*b* is a top view of the pump. Figs. 16, *a–c* represent, in vertical sections, side and top view, a sheet-iron mud-pump, worked by a rope and provided with a bullet-valve.

10,743 AN INSTRUMENT USED FOR WIDENING A BOREHOLE underneath the pipes in hard rock to a sufficient depth and width for working a tool, as represented in No. 10,736 (Plate XII., fig. 17), and No. 10,733 (Plate XIII., fig. 1, and Plate XV., fig. 15), to continue the wider bore, so that the pipes may be rammed farther down. (V., Drawing III.) Plate XIV., figs. 10, *a*.

The working edges of the two chisel-blades are brought into action by drawing up the wedge between the longer parts of the arms, which causes the latter to spread. If the instrument has to be withdrawn from the hole, the wedge is dropped, so that the arms approach each other by gravity, whilst the box-shaped guide which is placed around the upper part of the arms, and attached to the rod or wire by which the wedge is worked, is, at the same time, so far lowered that it will entirely cover the cutting edges of the blades, preventing thus the projecting parts of the instrument from coming into any injurious contact with the pipes. This instrument is also used for withdrawing iron or wooden pipes.

Plate XIV. represents the instrument either out of action, and suspended within the pipes, or in action, with chisels spread out underneath the pipes, in the figures 10 and 10*a*.

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10,733 SPRING-CHISELS (C, Drawing III.); Plate XIII., fig. 1, and Plate XV., fig. 15.

Used for continuing the boring of a hole, underneath the pipes, with a greater diameter than its upper part, after a tool similar to No. 10,743, or to No. 10,747 (Plate XIII., fig. 12), has been employed to clear a sufficiently wide space to a depth of about 3 or 4 feet for the admission of the instrument, the suspended chisel-blades of which, worked by a double spring, will then spread out for action to an extent regulated by short studs at the back part of the chisels within the casing. The blades are not provided with a mechanism to draw them in, when the instrument is to be withdrawn or lowered, but which would be necessary if made of larger dimensions, and consequently with stronger springs. The instrument is represented in the accompanying Plate XIII., where fig. 1 is a front elevation, showing the position and fixing of the lid of the chisel-casing and the projection of the expanded chisel-blades beyond the sides of the latter. Fig. 1*a* is a side view, and fig. 1*b* a view of the casing with the lid removed, showing the exact position of the chisels, their studs, and the springs. The dimensions of the instrument correspond with a hole of $4\frac{1}{2}$ inches, to be widened to a diameter of about 7 inches. The casing is 12 inches high, 4 inches wide, and $2\frac{3}{4}$ inches deep. The shaft is 18 inches long by 2 inches square, and provided with a male screw-socket. The blades are about 8 inches high, 1 inch thick, and $2\frac{1}{2}$ inches broad at their cutting edges.

Fig. 15, Plate XV., represents in a vertical section and a side view a similar instrument employed for the same purpose, but of larger dimensions, with a contrivance to expand the hinged chisel-blades by means of the screw-tapped head of the shaft, which passes through the cylindrical, muff-shaped top of the chisel-casing.

10,736 A CHISEL (D, Drawing III.)—Plate XII., fig. 17—to bore underneath the pipes.

This boring tool is used for a similar purpose as the preceding one, after sufficient space has been cleared underneath the pipes by another tool for its action. It is only used in hard rock and in holes of a wide bore. It consists of two flat arms, strongly hinged together, each of which is provided with a projecting, sharp-edged nose (at equal distances from the centre of the hinge), similar in shape to the corners of the chisel No. 10,730, II. *a* is a wedge, which is fitted between the arms and attached to a fork (*b*), to work it up and down by means of a rope for the purpose of bringing the chisels either in or out of action; *c* is a slide, which prevents the arms from spreading beyond the width of the bore; *d d* represent the lower part of the arms, which extend about half the height of the whole instrument beyond the cutting edges, and

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10,736 continued. serve as guides, within the narrow bore of the hole, to keep the wider bore always concentric with the latter.

Height of whole tool, 4 feet; length of hinged arm, $2\frac{1}{2}$ feet; length of guiding part of arm beyond cutting edge, $1\frac{3}{4}$ foot; diameter of socket, 4 inches to 5 inches; width of chisel when spread for action, 15 inches; width of chisel when drawn in for withdrawing the tool, $13\frac{1}{2}$ inches.

10,742 CONICAL RING-CHISEL (XI.); Plate XII., fig. 9.

This is a most efficient tool for trimming and enlarging a hole bored in soft rock. It consists of a high and slightly conical steel ring, the lower edge of which is sharpened to serve as a chisel, whilst to its upper edge, and partly to the inner side, the arms of the forked, square shaft are riveted or welded.

Dimensions.—Full height, $1\frac{3}{4}$ foot to 2 feet; vertical height of ring, 5 inches; lower diameter, $5\frac{1}{2}$ inches to 8 inches; thickness of upper edge, $\frac{3}{8}$ inch to $\frac{1}{2}$ inch: upper diameter, 4 inches to 6 inches; height of forked shaft above ring, 1 foot 6 inches.

10,741 TOOTHED RING-CHISEL (F, Drawing III.); Plate XII., figs. 10, 10*a*, 10*b*.

Used to trim and widen a borehole in rock sufficiently hard to stand without lining. It is preferable to the sharp-edged ring-chisel of a similar shape described above, for retaining its central and perpendicular position better, on account of its heaviness and broad, toothed, base. Narrow holes, out of plumb, can be easily adjusted with this chisel, the teeth of which are cut in a radial direction.

Vertical height of ring, $4\frac{1}{2}$ inches to 6 inches; respective diameters, 5 inches to 7 inches and 6 inches to 8 inches; thickness of ring, 1 inch; number of teeth, 20 to 24; height (average) of teeth, $\frac{3}{8}$ inch.

10,128 CONICAL BORER (B, Drawing IV.); Plate XII., fig. 21. (Mitre, bonnet de prètre or étoile.)

Used for trimming the bottom of a borehole, having a diameter of about 6 inches to 9 inches, into a conical shape for receiving the conical end of a wooden pipe of a corresponding size. This latter is closely rammed down for the purpose of shutting off the water from the strata above, thus preventing the washing out of a hole, the end of which may be situated in an impermeable stratum about 1 to 2 feet below a drift. It consists of a solid block of iron (in shape a conical frustrum), to the base of which the square shaft, of the usual form, is fixed, whilst its mantle is grooved all around with about ten teeth diverging at equal distances from the supposed point of the cone.

Length of tool, 2 feet; respective diameters of base and head, 6 inches and 9 inches; slanting height of cone, $7\frac{1}{2}$ inches; average height of teeth, $1\frac{1}{4}$ inch.

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10,128 continued. The fig. 21 of Plate XII. differs from the model by having the flat head of the latter formed into an obtuse cone, over which the teeth around the mantle of the upper cone run out into a point in the shape of a star. The teeth being steeled, this form of the tool is frequently employed for breaking through hard ground by percussion, and belongs then to the class of borers called "stone-breakers," as partly represented in figures 7 and 20 of the same Plate. Its respective diameters are 4 inches and $5\frac{1}{2}$ inches; slanting height of upper cone, $5\frac{1}{2}$ inches; perpendicular height of toothed head-cone, $1\frac{1}{2}$ inch; number of teeth around the mantle, 12; length of shaft, 15 inches. In narrow holes the head is made very slender by a length of about 18 inches.

10,731 BELL-SHAPED CHISEL (III.); Plate XI., figs. 17, 17*a*. Principally used for widening a borehole, but also for the purpose of centring and trimming, if the walls of the hole are rugged, or have an oblong shape.

The lower part or head of this tool is formed of a bell-shaped solid block of iron, which is hollowed out underneath to a depth of about 3 inches, and provided, at equal distances around its mantle, with four nearly vertical, semicircular flutes of 4 inches width (or about one-eighth of the periphery of the base), and 3 inches depth at the base, so as to form four equal chisel-edges around the latter, which are well steeled, and similar to those of the crown or cross-chisel (fig. 19). The upper part of the chisel is of the same construction and dimensions as that of the chisels described above (fig. 18).

Dimensions.—Diameter of base, $10\frac{1}{2}$ to 12 inches; length of chisel (without male screw), 2 feet 6 inches; height of head, 1 foot; section of shaft, $3\frac{1}{2}$ inches square (strongly chamfered).

10,740 THE CROWN-CHISEL (N, Drawing III.); Plate XI., figs. 19, *a*, *b*.

This percussion tool is formed by a combination of four hoe-shaped chisel-blades (Z), with curved, steel, cutting edges, which are welded crosswise and edge downwards to an octagonal or round block, provided with a square eye in its centre by which it is tightly fitted to a corresponding square neck-piece (A) on the upper end of the large chisel, for the purpose of trimming down obstructive projections left by the preceding chisel, but also for widening a bore. It is kept in its position on the main chisel (fig. 18) by the socket of the succeeding main rod (fig. 8*c*).

Fig. 19 represents a side view of the crown-chisel, showing its position on the square neck (fig. 18*a*) of the chisel-shaft (fig. 18). Fig. 19*a* is a top view, and fig. 19*b* a vertical cross-section through two of its opposite blades. Diametrical width between two cutting edges, 10 inches; height of eye-block, 3 inches; section, 5 inches diameter, or 5 inches square, with bevelled corners; width of each blade-edge, 5 inches; eye, $2\frac{1}{2}$ inches square.

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10,740 continued. Fig. 16, Plate XII., represents a side-edged double-bladed chisel, employed in combination with an ordinary triple-edged chisel for trimming or widening a borehole from 6 to 12 inches in diameter, and passing through hard rock when the crown-chisel, usually adopted, would be too weak, and subject to breakage or damage entailing repairs. It consists of a square shaft, 2 feet to $2\frac{1}{2}$ feet in length, and furnished at its ends with the usual male and female screw socket-joints; near the latter of which two of its opposite sides are drawn out into a "nose," and fitted with $2\frac{1}{2}$ to 3 inches wide circular cutting edges. The socket-joint between both tools is so arranged that, when the screw is brought home, the blades of the upper chisel remain fixed in a position oblique to that of the lower one, for the purpose of steadying the action of the strokes.

Fig. 12*a*, Plate XII., is another important tool, belonging to the same class as the preceding ones, employed for boring a cylindrical ring, so as to leave a core in the centre of the hole, which is afterwards taken out for the purpose of examining the rock, &c. It consists of a square shaft of the usual kind, attached to a short cylinder, around the mantle of which four long narrow-edged chisels, of a trapezoidal section, with sides slightly hollowed out, are fixed in a vertical position at equal distance one from another. This tool is, like all ordinary chisels, gradually worked round till an annular space bored by it has reached a depth corresponding to the length of the chisels, and, consequently, the base of the cylinder; after which the tool is cautiously withdrawn. The cylinder is partly hollowed out to a width touching the inner sides of the chisels, to prevent its injurious contact with the top of the core thus formed, if the chisels should have accidentally advanced beyond the required depth. To extract this core, another instrument, represented in Plate XIII., fig. 2, is introduced, consisting of a short shaft, attached to a cylindrical head of cast-iron, from 9 to 12 inches in height; which is bored to a depth and width slightly larger than those of the core, and furnished within the sides near its base with two bill-hooks, horizontally hinged opposite one another, and opening in one direction towards the centre. The tool being placed over the core, so as to cover the greater portion of it, a few sudden turns and jerks in the direction of the screw forces the hooks to spring out, which then pass either underneath the base of the cylindrical fragment, or penetrate its side or uneven edge sufficiently deep to prevent the latter, thus caught, from falling out during the withdrawal of the tool.

V.—AUXILIARY APPARATUS.

1. TUBES; RIVETING, LOWERING, AND RAISING TOOLS.

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10,751–52 TUBES FOR LINING BOREHOLES (XXVIII., XXIX., Drawing III.); Plate XIII., fig. 22.

These are only requisite when the walls of the boreholes will not stand without being supported. Tubes are always made perfectly circular, and either of wood, sheet-iron, or cast-iron, and joined in such a manner that the axis of a whole column forms a perpendicular line; their joints must be perfectly tight, so as to admit neither water nor any rock matter from the adjacent walls of the hole. The sides of the wooden tubes are generally from $1\frac{3}{4}$ to 2 inches in thickness, so as to resist the percussion of the ram by which they are driven into the hole (fig. 19). Wooden tubes are joined similarly to the wooden pipes of pumps, &c., by either a half-lap joint (fig. 18), or by an even joint provided with an iron, circular tongue (*see* fig. 17), the joints being in both cases surrounded by a strong, iron ring-collar, let into the wood. The head tube is always furnished with an iron, sharp-edged shoe (*see* fig. 19), whilst the top of the uppermost tube is secured by a strong ring during the time of ramming, which is afterwards replaced by the collar (fig. 17). Sheet-iron tubes are made of the longest available material, of $\frac{1}{8}$ inch to $\frac{1}{4}$ inch in thickness, and bent perfectly circular, so as to form a straight, single seam, which is either soldered or riveted. Two modes of coupling each pair of tubes together are in common practice. The lock-collar joint is one, where the collar is riveted to the lower tube, and provided, in its upper part, with a ⅃-shaped slot, whilst the succeeding tube is not riveted to the collar, but fixed into a close joint by means of an attached stud, which is let in and turned, with the pipe, into the corresponding slot (*see* fig. 24). By this plan, which can only be adopted in narrow and shallow boreholes, single tubes can be, with little difficulty, lowered and joined, or detached and raised, by means of an instrument represented in Plate XIV., fig. 3, which also serves for catching the collared portion of these rods when accidentally detached, and to withdraw them to the surface.

The other method is that usually adopted in holes from 6 inches to 9 inches in diameter, but also in smaller bores, and consists of a joint formed by a plain, high ring-collar, into which both corresponding ends of the tubes are either riveted or soldered, meeting in the middle of the collar. For larger holes double layers of sheet-iron tubes, called telescope-tubes, are adopted, by which means the joints of the perfectly cylindrical tubes are completely covered by the middle of the corresponding outer or inner tube, and riveted together above and below it (*see* fig. 23). Cast-iron tubes are only used for larger holes; they are about 6 feet to 9 feet long × $\frac{1}{2}$ inch to 1 inch in

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10,751 thickness, and fitted together, in the ordinary way, by means of a collar,
10,752 flange, or curb-joint. They are, however, not much in use, principally on
continued.
account of their weight and extreme brittleness. The most practically useful tubes, employed for holes of all widths, are those of a slightly conical form; they are made of sheet-iron, with a soldered seam, and fitted one into the other to the extent of 6 inches to 12 inches, till they come into close contact, each joint being fixed by two horizontal rows of strong rivets (*see* fig. 22). Large columns of tubes, constructed according to one of the plans described above, are generally prepared of a length not exceeding the distance between the top of the tower and the stage, and successively let into the hole, suspended and riveted till the head-tube has reached the point of its destination; but in many cases the single tubes are only joined above the mouth of the hole, one after the other, in proportion to the progress of the hole. It is never the practice to let single tubes into the hole for the support of only a certain defective part of the borehole; in this case a continuous column has to be always inserted, thus lining the hole entirely from the mouth down to beyond the damaged portion. The operations connected with the manufacturing, joining, supporting, and lowering the tubes, as also those for ramming, lifting, and extracting them, render necessary the employment of many auxiliary instruments, of which some of the principal forms are described below, and represented in the drawings and models in the Museum, and in the Plates of this Catalogue. The tubes, as shown in the models, &c., represent two sets, of a conical shape, for wide and narrow holes respectively, which are soldered, coupled, and riveted together, as described above, and each tube provided with two opposite vertical rows of ½ inch to 1 inch round holes, for the purpose of catching either a single detached tube or part of a column of tubes, by means of an instrument seen in Plate XIV., fig. 8, and described below.

10,718 CLAMP or VICE (XVI., Drawing III.); Plate XIV., figs. 1, 1*a*.

This tool is applied across the top of a borehole, where it is screwed around the pipes when they have either to be riveted or taken to pieces. It consists of two equal-sized blocks of hard wood, each of which is provided with a half-circular cut, which corresponds exactly with the outer periphery of the pipes; both blocks are connected and worked by means of four strong screw-bolts, passing horizontally through the ends of both blocks of the vice. Size of each block, 4 feet long, 10 inches wide, and 6 inches high. Diameter of circular cuts, corresponding to pipes of 13 inches diameter; depth of same, 5 inches. The clamp represented in fig. 1, Plate XIII., differs slightly in form and dimensions from the model. Its circular cuts are lined with cast-iron beds, and of a diameter for receiving 8-inch pipes. The screw-nuts of the bolts are provided with a handle.

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10,747 INSTRUMENT USED TO LOWER IRON PIPES INTO A BOREHOLE (A, Drawing IV.); Plate XIII., figs. 12, 12*a*.

The pipes are placed on the three bill-hooks (in some cases, as in fig. 12, only two), hinged in one horizontal plane, and at equal distances one from another, to a short cylindrical block of iron, which corresponds with the inner diameter of the pipes, and forms one piece, with its shaft of the usual shape. When the pipes have been lowered to the place designed for them, the instrument is then turned from the left to the right; the hooks then leave the edge of the pipe and enter the corresponding cavities of the block, after which the tool can be withdrawn to the surface. This instrument is also used in clayey strata for widening a hole underneath the pipes, either for the farther passage of the latter, or to provide room for the admission of a percussion tool to bore the hole wider through a hard layer. The dimensions of the model are as follow:—Diameter of block, $5\frac{1}{2}$ inches to 8 inches; height of block, 6 inches to 8 inches; length of shaft, 1 foot to $1\frac{1}{4}$ foot; thickness of hooks, $1\frac{1}{4}$ inch to $1\frac{1}{2}$ inch; distance between the centre of block and that of each hook, 2 inches.

10,701 INSTRUMENT FOR LOWERING IRON PIPES (XX., Drawing III.)—Plate XIV., fig. 8—of a diameter of from 6 to 9 inches.

Each arm of the fork of this apparatus is provided, on its outer side, with a row of five short hooks, slightly inclined upwards, which correspond exactly with a series of holes in the pipes (*see* No. 10,752). A spring is attached to the inner side of the fixed arm, which, by being allowed to act against the hinged arm, spreads the instrument, and forces the hooks into the corresponding holes of the pipes, when both are placed opposite each other. The pipes, thus brought in close contact with the tool, can be safely lowered into the hole to any place required; after which the hooks may be brought out of action by pulling the rope or wire in connexion with a knee-joint (or with an arrangement as seen in fig. 8) across the lower end of the arms which draws the movable arm in; so that the tool, by being slightly turned, may be withdrawn without bringing its hooks again into contact with the holes. Besides the spring, a pawl or click—hinged with one end to the inner side of the fixed arm, whilst the other end is free to act against a collar or stop on the hinged arm—is frequently applied to keep the tool spread during its descent till the pipe has arrived at its place, when the pawl is knocked out by pulling a wire or string attached to the free end of it.

The instrument, as shown in the model, is also used with great success for raising high columns of joined iron pipes.

Height of whole tool, 3 feet 6 inches to 3 feet 9 inches; number of hooks on each arm, 5; distance of same one from another, 5 inches; length of fork-arms, 2 feet 6 inches; section of same, $\frac{3}{4}$ inch to 1 inch by 1 inch to $1\frac{1}{4}$ inch.

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10,702 INSTRUMENT USED TO LOWER WOODEN PIPES, as also for boring underneath them (B, Drawing III.); Plate XIV., figs. 4, 4*a*.

To use this apparatus, which is provided with two curved spring-blades, acting upwards, it is necessary to notch the lower end of the lowest pipe of a column to be lowered for the reception of the broad top of these blades. When the instrument is thus brought underneath the pipes, and in close contact with the notches (as seen in sketch A), so that the whole column of pipes, when detached from the clamp (XVI., Drawing III.) around them at the top of the borehole, will rest on the expanded spring-blades, it is lowered into the hole, with the column of pipes on it, till the notched pipe enters the ring around the top of the upper fixed pipe in the borehole. Pushing now the instrument—which has already partly entered the bore of this pipe—slightly downwards, its blades are pressed against their springs, and slip, consequently, out of the notches, assuming the position seen in sketch B. After the pipes have been rammed in close joint, the instrument can be easily raised, as soon as the broad curved backs of its blades will come into contact with the bore of the pipes. In an instrument of larger dimensions, and, consequently, with stronger springs, the blades are drawn in by means of a rope or wire, which is attached to a knee-joint across their tops. Fig. 4 represents the instrument spread for action underneath iron pipes.

Height of whole tool, $3\frac{1}{4}$ feet; height of spring-blades, 9 inches to 10 inches; width of same, $2\frac{1}{2}$ inches; expansion of blades, 1 inch to 2 inches.

The different forms of spring-hooks, described and figured above, are not always strong enough to bear the weight of a column of thick cast-iron tubes, of 6 to 8 inches inner diameter, for lowering them to a depth of perhaps 200 feet, and to avoid any accidents which may arise by employing these tools, the following method, illustrated in Plate XV., fig. 14, has been successfully adopted. A low conical disc of hard wood, $2\frac{1}{2}$ to 3 inches high, is to be fitted exactly into the conical mouth of the lowest tube, and fixed, by means of a left-hand female screw in its centre to a corresponding male screw at the head of a square, chamfered shaft, $1\frac{1}{2}$ to $1\frac{3}{4}$ inch square, and 5 to 6 feet long, which again is attached to the working-rods in the usual way. The column of tubes, being placed on the conical disc, is then lowered till the bottom of the hole is reached, after which, by turning the rods in the usual direction from left to right, the shaft is detached from the disc, which remains and has to be destroyed by a cross-borer, &c., after the rods have been withdrawn. On a soft, sandy, or clay, bottom of a hole, the breaking up and extraction of the disc is, however, sometimes a difficult matter, for which reason it is necessary to cut out from its sides, and before the tubes are placed on it, four vertical and triangular notches, at equal distances one from another, and to a depth leaving only about 1 inch between the angle of the notch and the thread of

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10,702 continued. the centre screw. After the tubes have been lowered, and the rods screwed off the disc thus notched, a wood-auger is introduced into its left-hand tapped centre-hole, which is then widened to such an extent that the whole disc breaks up in only four pieces, formed of the parts between the notches; they are floated upwards by the water in the hole, and thus taken easily out by the mud-pump.

In some instances the disc has been made of plaster of Paris, so that it could be quickly broken up into small fragments.

Figs. 5 and 6, Plate XIV., represent two very simple instruments, principally employed for lowering tubes, but also, in many instances, with equal success, for extracting them. Fig. 5 is a SPRING-HOOK, consisting of two wrought-iron forked arms, 4 feet in length, springing out from a short square rod; they are made to open by their own elasticity farther than the outer diameter of the tubes, for the reception of which they are provided at the ends with a hook. The combined actions of these hooks do not damage the edge of the lowest tube, as is done by the *single hook*, fig. 7 of same Plate; but the instrument is often inconvenient in its simplest form, because it remains frequently fixed, and causes often great difficulties to disengage the hooks after the tubes have been lowered. This, however, can be obviated, when the diameter of the hole is large enough to admit the insertion of a small *auxiliary rod* (besides the one at work, which requires at least a diameter of 5 inches to 6 inches), to the end of which a rectangular iron frame or a ring is fixed for the purpose of surrounding the spring-arms of the instrument. If the frame is adopted, the same is at once put over the arms before the tubes are placed on the hooks, drawn up as far as the socket, and thus separately suspended, cautiously lowered with the instrument; whilst the ring arrangement, which is considered the most practical, is only applied when absolutely necessary, and then put over the rods of the instrument, and upon the latter when the tubes have reached the bottom of the hole. By the weight of this auxiliary rod, if allowed to descend and act upon the arms of the instrument, the ring or frame forces the same to close, so that the whole can be withdrawn, leaving the tubes behind. The arms being only of a small section, their elasticity is often overcome by the excessive weight of the suspended tubes; for which reason it is advisable to employ the instrument only in holes having a diameter of 4 inches to 5 inches.

THE SHEAR-HOOK—Plate XIV., fig. 6—is a very convenient instrument, similar in construction to the preceding one, but chiefly applied for lowering or raising iron tubes of large diameter. One of its arms is fixed, to the upper square part of which, about 1 foot below the male screw, the other arm is hinged; whilst both are provided with hooks like those of the spring-hook (fig. 5). Towards the base of the arms a bar is vertically hinged with one end to the firm branch of the tool, its other extremity being forked, to fit

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the movable branch of the tool, on which is a shoulder attached opposite the hinge, to prevent the bar from tipping below its level position. The hooks of the suspended instrument are fitted, above the surface, underneath the edge of the head-pipe, which is only temporarily suspended, by pushing down the bar upon its seat, after which the instrument is lowered, carrying the tubes, now made loose, upon the hooks. Thus arrived at the bottom of the hole, the instrument is then disengaged from the tubes, by pulling up the bar by means of a rope attached to an eye near its forked end. When the instrument is used to extract pipes, the bar has then either to press, by its own weight, against the hinged arm till falling on its seat, or it has to be pushed down by means of an inserted iron auxiliary rod.

10,699 TUBE EXTRACTOR (XII., Drawing III.); Plate XIV., figs. 11, *a*, *b*. Principally used for raising iron pipes out of a borehole, and in some cases for lowering them. (Figs. *a*, *b*, *c*, Museum Drawing III., represent the instrument in its different positions when applied.)

It consists of a hinged iron fork; to the ends of each of its arms a long wooden block (*c*, *c*) of a segmental section is bolted; these are formed by cutting a wedge-shaped piece (A) out of a slightly conical cylinder. The dimensions of the latter, before it is cut into two parts, correspond exactly with the inner dimensions of the pipes at their wider ends (Plate XIII., fig. 22), so that, when no wedge is inserted between the cheeks and blocks, which then hang down and are brought nearer one to another by gravity, the instrument can be easily lowered without coming in close contact with the pipes. It is screwed to the rods, and having thus been lowered below the edge of the second pipe of a column to be extracted, and the wedge having been dropped between the two segmental blocks, the latter are separated and brought into close contact with the edge and the side of the pipes, after which the whole column can be safely raised. The guide (H) across the upper portion of the fork, and attached to the forked arms of the wedge, serves to prevent the two arms of the blocks from being driven farther than a little beyond the greatest diameter of the pipes. (The sketch, Plate XIV., figs. 11, *a*, is represented without the guide.) Whole length of instrument, 6 feet to $6\frac{1}{2}$ feet; height of blocks, 3 feet; wedge, 3 feet high, $2\frac{1}{2}$ inches and 1 inch thick at respective ends, and $8\frac{1}{2}$ inches wide.

Fig. 14, Plate XIV., represents a simple but efficient apparatus for withdrawing iron tubes. It consists of a round wooden block, 2 feet in length, and of a thickness corresponding to the inner diameter of the tubes. Its centre is bored for passing an iron rod through, with a washer and screw-knot at its end, upon which the globular head of the block rests, whilst the upper half of the latter is conically reduced by 3 to 4 inches to a narrower flat top (in some cases the rod, with a solid large head at its end, is inserted by

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10,699 continued. sawing the block vertically into two equal parts, which are fitted around the rod and bound by two iron rings), and frequently capped by a corresponding sheet-iron cone of a greater height. If the column of tubes to be extracted extend to the surface, the mere block, as described, is at once lowered till arrived at the lowest of them, after which coarse sand and pebbles are filled into the hole to cover the block to a height of about 6 feet, which thus, when raised, is perfectly jammed in by the sand around it, and consequently acts as a wedge driven upwards; either the bursting of the tubes or their successful extraction must follow. If the tubes do not reach the top of the hole, it is necessary to place over the rod on the conical top of the suspended block, before it is lowered, a sheet-iron cylinder, 6 feet long, a few inches less in diameter than the inside of the tubes, and filled with sand, &c., its upper edge being provided with a handle to which a rope is attached. Thus loaded, the block is cautiously lowered to the lowest tube, after which the cylinder is raised and withdrawn, so that the whole of the sand is now distributed over the block, which then is raised, carrying the tubes with it, as described above. The iron rods must be of a section not less than 1¼ inch to 1½ inch square, especially in cases where it is known that the tubes stick fast and require great power to force them upwards.

THE T-SQUARE, as shown in figs. 13, *a*, Plate XIV., is another efficient instrument employed for raising (and, in many cases, also fit for lowering) wooden tubes.

It consists of a square, chamfered iron shaft, 3½ feet to 4 feet in length, which is usually fixed to the rods by a dovetailed lap or fork-joint, whilst its broader head is provided with a rectangular vertical slit, into which a short iron bar of a corresponding thickness, by a height of 2½ inches to 3 inches, and of a length equal to the outer diameter of the tubes, is hinged in its middle near the upper edge, so as to swing easily on the pin. When the tool is to be inserted into the pipes, the bar is then drawn upwards, and thus partly covered by the forked slit in proportion to the width of the bore (fig. 13*a*); but as soon as the whole slit of the head has passed the base of the lowest of the pipes to be extracted, the bar swings round into a horizontal position, upon which then the tubes will be safely rested and extracted by the withdrawal of the tool.

11,700 EXTRACTOR USED TO RAISE WOODEN PIPES OUT OF A BOREHOLE (X., Drawing III.); Plate XIV., figs. 9, *a*.

It consists of a square wrought-iron shaft, 4½ feet long, drawn out on its upper part into a slender neck, ending with the usual male screw for joining it to the rods. A series of small, strong, wrought-iron bill-hooks are hinged, point upwards, within corresponding mortises, sunk in a spiral direction, or

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11,700 continued. alternately one opposite the other, into the parallel sides of the square portion of the shaft. By lowering the tool through the bore of a column of wooden pipes the sharp-pointed hooks are gently pressed against the sides of the shaft, touching the pipes only with their blunt and curved backs, whilst they fall farther out and enter the pipes as soon as the instrument is drawn upwards, carrying thus the tubes up to the surface. In many ordinary instances this tool has answered the purpose, but has proved a great source of trouble in cases where it had to be withdrawn without the pipes. Length, $4\frac{1}{2}$ feet; shaft, $2\frac{1}{2}$ inches square; neck and screw, 15 inches long; vertical distance between hooks, $2\frac{1}{2}$ inches; number of hooks, 20; length of same, $2\frac{1}{2}$ inches.

10,705 APPARATUS FOR RIVETING IRON PIPES (J, Drawing III.); Plate XIV., figs. 12, *a*.

It consists of two half-circular, slightly conical blocks of wrought-iron, which are suspended from a hinged iron fork, and correspond, when spread to a certain extent (by an iron wedge forced bewe en them [*see* description in No. 10,699]), exactly with the lowest or narrowest inner part of a pipe, pressing thus the respective ends of the inner and outer pipes to be joined and riveted, tightly together, and serving as an anvil to withstand the blows of the hammer upon the rivets stuck in from outside. The holes on the inner side of the inner pipe are generally sunk conically to a depth sufficient to receive the head of the rivet. The wedge is worked by being attached to a separate iron fork, bent outside and screwed to a series of rods independent of those to which the fork of the blocks is screwed. Wedge, 12 inches high, $2\frac{1}{2}$ inches at base, and 8 inches wide; height of whole instrument, 3 feet; height of blocks, 6 inches.

V.—AUXILIARY APPARATUS (2).

CATCH INSTRUMENTS EMPLOYED TO CLEAR A BOREHOLE OF OBSTRUCTIONS.

Many of the obstructions are due to unforeseen accidents, in consequence of carelessness and want of caution of the workmen. In well-managed boring works the principal instruments constructed for the purpose of clearing and extracting the obstructing objects are always kept in readiness for speedy application when the accident suddenly occurs. If any serious accident or obstruction should occur in holes not yet carried down to a great depth, it is usually considered a wise course to abandon the hole at once, and commence a fresh one. In nearly all cases the aid of the boring-rods is indispensable. The principal causes of accidents are—

1. *Separation of the rods* at their joints, for which the *Trumpet* (Plate XV., figs. 3, 4) is usually brought into use.

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2. The *breaking of a rod* above the joint. In this case the different kinds of *hooks* (Plate XIV.) and the *fall-shears* (Plate XV., fig. 11) are generally found effective.
3. The *breaking of a rod* in the middle of its length, for which case the above fall-shears and the *twisted scrapers* (XIV., 21, and Plate XV., fig. 1) are generally applied.
4. *Breakage of portions of the boring-train* near the bottom of the hole, and the falling in of any foreign matter.
5. The *tearing of the rope* suspending the mud-pump. The scrapers, double and single, as also several of the hooks, are in most of these cases found effective instruments.
6. The *breakage of the cylinder* of the mud-pump or its *separation* from the rods or rope, either by the breakage of the latter or its handle. The *spring-hook* (XV., fig. 5), as well as *several hooks* (XIV., figs. 7, 16, 15), are the best tools to be used in one or the other of these cases.
7. The *jamming of the boring-rods* from boring-tools, &c., falling in from the top of the hole; the breaking of the rods through excessive action or through obstruction from below, and the obstructions caused by the walls of the holes giving way or the contortions or tearing of the tubes.

10,717 THE ROPE-CATCH (IX., Drawing III.); Plate XIV., fig. 21. Used to search for the lost or broken rope of the mud-pump, &c.

It consists of a square shaft, 2 feet long, with the usual male screw and collar at one end, and a spiral screw, like a corkscrew, at the other end. When used, it is continually turned in different directions, until one part of the rope is caught and sufficiently entangled within the screw-head, which is about 6 inches to 8 inches long, with 5 inches for its largest diameter at the end.

THE DOUBLE SPIRAL HOOK or SCRAPER—Plate XV., fig. 1—is another instrument of similar construction, and employed for withdrawing coarse gravel or fragments of broken tools, &c.

It is made of square or round iron turned into three to five screw spirals. The principal strength of the double screw-head depends on its proper connexion with the short square shaft of the tool; but however strong the whole instrument may be made, it must be cautiously applied, to prevent either the breaking of any part of the screws, or its bending outwards to a larger diameter than that of the hole. It is often employed through certain sands with an equal effect to that obtained by a shell-auger; sands of a clayey nature are easily retained within its windings. It was especially found to be of great utility in extracting large fragments of the flint embedded in chalk. Whole length of tool, 2 feet 6 inches; length of double spiral-head, 16 inches to 18 inches; diameter of head, 5 inches to 6 inches.

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10,723 THE PLAIN HORIZONTAL HOOK (Drawing III.; XXVII.).

This tool, being screwed directly to the lowest rod, is only used for catching and raising broken or bent rods, as also fragments of different tools, ropes, &c. It consists of a square shaft with a male screw similar to those of the preceding tool, whilst its lower end is drawn out flat, at a right angle and in one plane with the axis of the shaft, into an S-shaped blade of about 8 inches in length, $1\frac{1}{2}$ inch average thickness, and 3 inches to 4 inches high, the end of the upper edge gradually curving down to a point.

Figs. 15, 16, 17, and 18, Plate XIV., represent four different hooks employed for a similar purpose, of which the two latter ones resemble the model, with the difference, that the hook of fig. 18 is also provided with a rectangular shoulder on its inner side, near its junction with the shaft, for the support and suspension of the rods, &c., caught under their sockets, collars, &c., whilst fig. 17 is made entirely of round iron, bent round into a horizontal excentric hook, pointed at its end. Fig. 15 is a *single common bill-hook*, attached to the rods, and principally employed for catching the handle of a detached mud-pump (as represented in the figure) or guides, forked portions of tools, &c. For catching and righting detached, broken, or inclined tubes, the form represented in fig. 7 is generally adopted. Fig. 16 is a *double* or *harpoon-shaped hook*, which is usually worked by a rope, fastened to an eye at the upper end of its square, chamfered shaft of about 2 feet length by 2 inches square section; the width between both points of the hook, 5 inches to 6 inches.

THE STIRRUP. Fig. 19 of the same Plate represents a tool, generally known, on account of its shape, by the above name. It is found to be very efficacious in extracting rods broken below their socket or collar, from narrow holes of 3 inches to 5 inches in diameter. It consists of a square shaft $2\frac{1}{2}$ feet long, near the lower end of which a semicircular hoop is tightly hinged, so that it remains at the given angle of its position, unless forcibly moved; the upper end of the shaft is attached to the rods by either a screw-socket or lap-joint. When applied, the hoop is raised, and consequently opened to an extent which allows the broken rod to enter, after which the instrument is withdrawn, bringing the hoop into close contact with the rod caught within by the friction and the weight of the rod, which, thus pressed by the hoop against the shaft and the wall of the hole, can be easily raised to the surface. In holes of only 3 inches diameter the shaft does not project farther beyond the hinge-bolt at its lower end than the clear depth of the hoop, whilst the dimensions of the tool are smaller than those of the sketch.

THE GOAT'S FOOT, fig. 20, is an instrument frequently employed for extracting broken or detached rods by seizing them under their socket or collars by means of a short forked head, forged at a right angle to the

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straight shaft, $2\frac{1}{2}$ feet to 3 feet long, the upper end of which is generally connected with the rods by a dovetailed fork-joint. The width between the arms of the forked foot exceeds slightly the thickness of the shaft or that of the rod to be caught, whilst the ends of these arms are frequently turned upwards about $\frac{1}{2}$ inch to 1 inch, to prevent the rods, when caught and suspended, from sliding off.

10,722 THE SPRING-CATCH (Drawing III., D); Plate XV., fig. 5. Used especially to catch and raise the cylinder of a mud-pump, when accidentally separated from its handle; also applied for catching broken ropes, wires, and shell-augers.

It consists of a square shaft 3 feet to 4 feet long, and male screw of the usual shape, the lower end of which is slightly drawn out to a blunt point and provided with four strong springs, fixed opposite to each other and alternately on the sides of the shaft, like an arrow-head. Forcing this tool beyond the ring, which is generally riveted to the inner side around the top edge of the tube of a mud-pump or some of the augers, and raising it afterwards, the broken or lost implement, thus entered, must follow, as the points of the springs, pressed forcibly against the sides, are prevented from passing the projecting ring.

10,724 TOOTHED SPRING-CATCH (G, Drawing III.); Plate XV., fig. 2.

This catch is principally employed for catching and raising broken rods, &c., but it is likewise applied to extract any loose lumps of clay or rock which may obstruct the progress of the borer. It consists of a short square shaft, to the sides at one end of which are welded or riveted four strong inside and outside curved springs of equal length and shape, and provided with barbed hooks on their inner side, so that any fragment of stones or tools, &c., entered and forced within the four contracted springs, will be kept and prevented by the teeth from falling out, unless its weight is too great. Length of arms, $1\frac{1}{2}$ foot; whole length of tool, $2\frac{1}{2}$ feet to 3 feet; number of teeth on each spring, 4 to 5.

THE SINGLE-FORKED SPRING-CATCH, represented in fig. 10, Plate XV., is another, but simpler form of catch, employed for the same purposes as the instruments figs. 2, 6, 8, and 9, described above.

It consists of a short square shaft of the usual form, to the lower end of which two long steel springs of great strength, acting inwards, are welded at an acute angle, so as to form a slender fork. The head of each of the spring-arms is horizontally drawn out to a broad shoe of a segmental form, both being alike and projecting at equal lengths right and left of their arm, forming

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a narrow, circular ledge for the support of a collar, socket, &c., of a rod. When applied, the spring-arms have to be spread out by means of a piece of wood (similar to the shears of fig. 11 of same Plate), which, however, is knocked out as soon as the rods to be removed have entered the widened mouth of the tool, thus causing the spring-arms to close in and to bear underneath the sockets, &c., of the caught rod, which then safely rests on the circular shoes during the withdrawal of the tool. Whole length of tool, 3 feet; spring-arms, $1\frac{3}{4}$ foot to 2 feet; width between springs, when spread, $4\frac{1}{2}$ inches to 5 inches. The lower inner edge of the shoes is generally strongly bevelled.

THE CONICAL SCREW-TAP or TRUMPET, represented in an improved form in Plate XV., fig. 3, is one of the best instruments to remove the fragments which almost cover the centre of the hole, or which only touch its sides without passing beyond its original circumference, or that of the tubes. It can be applied with certainty to extract whatever objects may be searched for, provided that the threads of the conical female screw are sufficiently strong to bring them to the surface. The instrument consists of a cylinder, widened at its head to allow an easy entrance of the objects sought for, as also the discharge of the debris accidentally entering its interior part, which is tapped with a conical screw of numerous threads. The screw must be high enough to take hold of the sockets of broken rods or the diagonal of the square parts of them. The screw-tap being attached to a forked shaft, the manner in which the instrument is worked is, to turn it in the direction of the screw until it is ascertained that the fragments have entered. When the piece looked for is short, and probably resting in the borehole in an inclined position, a sheet-iron mantle, cut oblique to its axis, is screwed to the screw-tap (as represented in fig. 3). The lowest portion of this appendage is then brought in contact with the broken or detached tool, which, on the slightest turning of the instrument, is sure to enter the mantle and then to be grasped by the threads of the screw.

THE COMMON SCREW-TAP—Plate XV., fig. 4—is employed when a rod or instrument only gets unscrewed. It consists of a *common female screw-socket* of a corresponding number, furnished with a short conical ring around its mantle in case the borehole being wide, the naked screw-socket alone might not readily meet the rod.

THE CROSS-FORKED BILL-HOOK TRAP—Plate XV., fig. 9—is also an instrument which has been, in many instances, successfully employed for extracting lost or broken rods of a large section, viz., main rods, &c., by their socket or collars, supposing the piece searched for can be placed in a

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vertical position, or nearly so. It consists of four straight, vertical arms of a rectangular section, which are welded to a short square shaft at right angles one to another, so as to form a cross-fork. The inner side of each arm is furnished with four to six movable bill-hooks, arranged in sets of four, which are placed on one level and at equal vertical distances. The hooks are hinged, within a corresponding mortise of the arms, like those of the tube extractor, Plate XIV., fig. 9, but acting towards the axis of the tool, so that, when the hooks are down on a level, a space of only 2 inches to $2\frac{1}{2}$ inches is left between their points. The rod, gradually entering the four arms of the tool, raises all the hooks of each set; these fall back to their level immediately after they have been passed, so that every set of hooks affords a secure seat to the socket or collar of the rod, &c., thus caught, during the withdrawal of the tool. For extracting broken or detached wooden boring-rods, this tool has been also frequently applied with success; the hooks enter the wood, forced by the weight of the latter, when suspended, whilst withdrawn from the hole. Length of whole tool, $3\frac{1}{2}$ feet; distance between opposite arms, 5 inches; length of arms, $2\frac{1}{2}$ feet; vertical distance between each set of hooks, 6 inches; radius of hooks, 2 inches to $2\frac{1}{4}$ inches; section of arms, 1 inch by $1\frac{1}{2}$ inch.

10,716 CATCH or CROWN HOOK (Drawing III.); Plate XV., fig. 7.

XIII. This is an instrument especially made for seizing a *Crown-chisel*, *Guide*, &c., underneath the corresponding, cross-shaped arms. (Nos. 10,740, 10,712; VI., XXIII., and XXXV., Drawing III.) It has some resemblance to the former tool, except that its four arms act not as springs, are without teeth and straight, and their ends turned over at a right angle towards the right side, forming thus short and slightly curved hooks. Height of tool, 2 feet 4 inches; distance between opposite arms, 4 to 5 inches; length of shaft, 6 inches to 7 inches; length of hooks, 2 inches.

10,714 TOOTHED CATCH INSTRUMENT; Plate XV., fig. 11. Used for

VI. extracting broken or unscrewed rods, joints, or any fragments of a slender shape.

The instrument consists essentially of two parts, viz., a fork with a steel ring attached to its ends, and a toothed spring-shears riveted to a square collar, by means of which they can slide up and down a given distance on the short neck of the fork. The springs are slightly bent outwards, above their toothed part, converging again within the ring, which is of a conical form, with its narrower part riveted to the ends of the hook. On the outside of this ring, and partly to one of the arms of the spring, a hook, bent inwards, and similar to the one described in No. 10,723, is riveted, with its flat handle projecting about 10 inches to 12 inches, in a vertical direction, beyond the

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10,714 lower edge of the ring, for tracing any fragment, &c., in the borehole, and
VI. continued. guiding it, when caught, towards the spread shears. Height of the whole tool from the lower edge of the ring to the screw, 7 feet; length of shears, 6 feet; respective diameters of ring, 7 inches and 9½ inches; height of ring, 7 inches; length of the toothed part of the shear-arms, 18 inches.

Before this instrument is applied, the toothed shears are drawn up close to a collar on the neck of the fork and spread by a wooden peg. Being thus prepared, it is lowered till it comes into contact with the object sought. As soon as the latter has entered the conical ring and shears, the peg is knocked out, the shears consequently must fall down, thus embracing the object within the ring. Raising now the rods and the conical ring attached to them by means of the fork, the toothed shears, increased in weight, will be forced deeper into the ring, and consequently pressed with greater force against the object between their teeth, so that the whole instrument, including the charge, may be safely brought to the surface.

10,715 SINGLE CLACK-TRAP; Plate XV., fig. 6. Used for catching and
VIII. extracting the joints and collars of broken or lost rods.

It consists of a plain fork riveted with the ends of its straight arms to the outer mantle of a cylindrical ring, on the top of which a strong broad plate, slit in the middle to a width corresponding with the thickness of the rods, is hinged across the centre. As soon as any joint or collar of a rod has entered the ring, and is pushed upwards by lowering the tool, the fork-shaped plate or trap is lifted, but falls back upon the ring, assisted by a spring, immediately after passing the joint, &c., and the entrance of the square naked part of the rod into the slit. The tool can then be raised, retaining safely the rod, thus caught, suspended by its socket or collar, &c., from the trap. Whole length of tool, 2¾ feet to 3½ feet; height of ring, 4 inches to 5 inches; width of trap-plate, 3 inches to 3½ inches; section of fork-arms, 2 inches by 1 inch; outer diameter of ring, 7 inches to 8 inches; inner ditto, 4 inches to 5 inches (greatest outer diameter of conical ring, 8 inches).

Fig. 8 of Plate XV. represents a modification of the preceding tool, having, instead of the single fork-trap, two flat and equal-sized clacks, hinged to the tool-arms immediately above the ring; the straight central edge of each clack is provided in its middle with a rectangular notch; these are exactly opposite one another, and form, when the clacks are down on the ring, a square aperture around the axis of the tool, corresponding with the section of the rods to be caught. The ring of this double clack-trap is stout and cylindrical, and the method of working it the same as that of the single-forked clack-trap. Preference is generally given to the double clack, although the other works nearly as well.

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10,746 THE WATER-TESTER (Drawing IV.); Plate XV., fig. 12.
V. Instrument used to ascertain whether fresh water exists at low levels within a borehole, when the water near the surface is brackish.

It consists of a narrow high cylinder of sheet-iron, provided near its top and bottom with a conical valve-seat, upon which the respective valves rest. Both of the valves are of the same size, and fixed to a single round rod (which is guided by crossbars within the cylinder), at a distance, one from another, corresponding to the position of the seats, so that the latter are opened or shut simultaneously. To the lower end of the valve-rod, which projects about one foot beyond the bottom of the lower valve, a cylindrical weight is screwed, which keeps the valves shut down upon their seats during the time the instrument is lowered or raised; the upper part of the cylinder is riveted to a fork, to the short neck of which the rod or the rope for working the tool is fixed. When the instrument is let down the borehole, the valves will remain shut from the weight below, thus preventing the water from entering the cylinder; but as soon as the attached weight touches the bottom of the borehole, the valves are pushed up and opened to an extent regulated by means of two collars on the rod, so that the water near the bottom, to be tested, rushes into the cylinder from above and below. Thus filled in a moment, the instrument is raised, and immediately the valves shut again, retaining the water within the cylinder, and preventing its mixture with that nearer the surface.

10,744 THE CLAMP or IRON SAFE-GUARD; Plate IX., fig. 9, *a*, *b*.
XXVI.

This apparatus is screwed during the process of widening or trimming a borehole to the square or round top-rod of the whole train of rods and gear, to prevent them from falling into the hole, if the boring-chain, swivel, handle, &c., situated above, should break, in consequence of a sudden descent of the borer, from either cutting through very soft strata or breaking into a cavity. It is also used when, during the withdrawal or lowering of the rods, one of them has to be caught between the collars or sockets for its support upon the *forceps*. The *clamp* is made of wrought-iron plate, 2 inches thick by 15 inches to 18 inches long, and about 8 inches wide across the middle when closed, and similar in shape to the *forceps* described above (fig. 14, Plate IX.), with the exception that the two plates are at one end laterally hinged in the usual way and independently of any support from underneath, and that they are worked by means of a screw-bolt (*c*) passing transversely through both of the other ends of the plates, which are drawn out narrower, and thickened for that purpose.

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THE RAM or PESTLE, illustrated in fig. 13, Plate XV., is another useful auxiliary percussion tool.

It is employed for puddling up the bottom of a narrow borehole, either to prevent its caving in from having penetrated into a thick stratum of flowing sands, &c., or to stop the rise of brackish water from a strong spring suddenly pierced by the borer. It consists of a wrought-iron round or square shaft, which is attached to the rods by a male screw-joint, and provided with a spherical head of a diameter corresponding to that of the hole.

Nos. 18,879–82. -Drawings I. to IV.

FOUR COLORED DRAWINGS, EACH 2′ 4″ × 3′, REPRESENTING ELEVATIONS AND SECTIONS ILLUSTRATIVE OF THE APPLICATION OF THE MACHINERY AND IMPLEMENTS USED IN BORING FOR SOLID MINERALS AND WATER, INCLUDING THE GREATER PART OF THE MODELS AND SKETCHES DESCRIBED ABOVE.

Museum No.

18,879 DRAWING I., representing—

1. KIND'S HYDROSTATIC FALLBORER (original invention), a general description of which is given above, page 39, No. 5,841. ($1\frac{3}{4}''$ to 1′.)

W, front elevation, with the borer down and the front plate partly removed; X, side elevation, with the borer suspended; Z, full front elevation; Y, front elevation, with the borer suspended and part of the front plate removed. Portions of apparatus: T, head of boring-rod; L, L′, square and flat portions of neck of apparatus, screwed to T; P, P, wrought-iron plates of casing or sheath, fixed by means of the screw-bolts *d*, *d*... to the flat part L′ of the neck; A, parachute or piston, made to slide a short distance up and down the square part L of the neck; *e*, *e*, guide-cheeks of sliding-gear, attached to the piston and connected with the neck L by the screw-bolt *x*, passing through a slot in the latter and through both of the cheeks; *c*, *c*, two arms, screwed to the piston by the knots *u*, and attached by means of the screw-bolt *r*, with their curved lower end, to a vertical guiding-bar *t*, which works in a corresponding slot of L′; V, V′, two shear-arms, hinged between the plates P by means of the screw-bolts *b*, *b*, and connected with the head of the guiding-bar *t* by the short joints S, S; R, top rod of boring-gear, made to slide within the casing P of the apparatus; Z, harpoon-hooked top R, corresponding to the hooks of the shear-arms V; O, stop-shoulder, fixed to R, for regulating the stroke; *f* and *s*, rectangular collars, fixed by the screws *a* around the casing P, for tying the same, and for guiding and stopping the rod R; F, female screw-socket at the head of R, attached to the cylindrical top part of the main boring-rod J, over which the guide (No. 10,711; Plate XI., fig. 13) is placed and thus fixed; N, tubes; A′, borer; G, crown-chisel (No. 10,740; Plate XI., figs. 18, 19).

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2. V=ELEVATION AND PARTIAL SECTIONAL VIEW OF KIND'S WOODEN BORING-RODS, employed for working the Fallborer. (For its description *see* Nos. 15,017 and 12,084, Plate VIII., fig. 18.)

I, wooden portion of rod; *l*, junction piece for connecting each succeeding pair of rods; K, octagonal female socket, with conical shaft *h*, around which a conical sheet-iron tube *n*, receiving the wooden rod I, is fixed by two bolts *r*; *t*, wooden wedge, driven home, to fix the rod I within the tube *n*; T a short iron rod, corresponding with the one screwed to the neck of the fallborer. The scale is the same as that of both models.

11,880 Drawing II., containing—

1. A SQUARE PYRAMIDAL BORING-TOWER of about 22 feet in height, for boring to a depth of 500 feet or more, with a double-armed lever-beam placed at half-height of the tower, and worked indirectly by the downward action of the cams on a windlass below, against the head of a single lever, which is connected with the end of the long arm of the main lever by a swivel and iron rods.

The boring-rods are balanced by a counter-weight P attached to a lever in connection with them above the surface or boring-stage. This apparatus, represented in two elevations (A and B), one ground plan (D), top and side view of the boring-lever (III.), and suspended end of the balance-lever (II.), is similar to that described above as Degousée's boring apparatus (Plate IX., figs. 1–7). A, tower; D, main lever; *t*, single auxiliary lever; F, windlass; N, cams (of wood); J, saddle; Z, swivel and connecting rod; *f*, boring handle for rotatory borings; L, windlass break; *h*, surface-pipe, with forceps attached to its cap.

2. SEVERAL BORING TOOLS AND CATCH INSTRUMENTS, viz.:—Conical Screw-tap or Trumpet, *d* (Plate XV., figs. 3, 4); the Hook, *b* (Plate XIV., fig. 18); the Boring Forceps, VI. (No. 10,745, and Plate IX., figs. 14 and 15); and two Shell Augers, one cylindrical, with one clack, V. (Plate XIII., fig. 5), and the other, VII. (Plate XIII., fig. 11), open, with a spiral point.

Museum No.

18,881 DRAWING III.

ILLUSTRATIONS OF BORING INSTRUMENTS, showing their action, all of which are either represented in the Models or in the accompanying Plates, and described under the following numbers and letters :—

1st.—*Models.*—(1″ to 1′.)

B = No. 10,702 ; Plate XIV., fig. 4.
C, a, b, c = No. 10,733 ; Plate XIII., fig. 1.
D = No. 10,722 ; Plate XV., fig. 5.
IV. = No. 10,740 ; Plate XI., fig. 19.
V., *a, b* = No. 10,743 ; Plate XIV., fig. 10.
F = No. 10,741 ; Plate XII., fig. 10.
G = No. 10,724 ; Plate XV., fig. 2.
J = No. 10,705 ; Plate XIV., fig. 12.
VII. = No. 10,703 ; Plate XI., fig. 9.
IX. = No. 10,717 ; Plate XIV., fig. 21.
XII., *a, b, c* = No. 10,699 ; Plate XIV., figs. 11, 12.
XIV. = No. 10,736 ; Plate XII., fig. 17.
XV. = No. 10,708 ; Plate XI., fig. 12.
XVII. = No. 10,737 ; Plate XI., fig. 15.
XVI. = No. 10,718 ; Plate XIV., fig. 1.
VIII., *c, d* = No. 11,700 ; Plate XIV., fig. 9.
XX., *a, b* = No. 10,701 ; Plate XIV., fig. 8.
XXIII. = No. 10,716 ; Plate XV., fig. 7.
XVII. = No. 10,723 ; Plate XIV., fig. 18.
XXXI. = No. 10,709 ; Plate XI., fig. 11.
XXXIII. = No. 10,710 ; Plate XI., fig. 8.
XXXV. = No. 10,711 ; Plate XI., fig. 13.

2nd.—*Sketches.*—(1″ to 1′.)

K = Plate XV., fig. 9.
E = Plate XV., fig 10.
A = Plate VIII., fig. 1.—($\frac{1}{4}$′ to 1′.)
S = Plate XV., fig. 14.
Z = Plate XIII., fig. 19.
N = Plate XIV., fig. 20.
L = Plate XIV., fig. 1.
H = Parachute and Guide (*d*).

I = Chisel for boring holes of large diameter, showing an arrangement to prevent its becoming detached from the socket of the main rod during use.

Museum No.

18,882 Drawing IV., containing—

1st. A THREE-LEGGED PORTABLE BORING-TOWER, for boring holes to a depth of 50 to 300 feet, by means of a double-armed lever-bar (O), directly worked by men; the winding-gear, consisting of a horse-whim (*t*), for ordinary windings, and a windlass (*w*) for working the mud-pump, both being attached to the two-legged frame (*e*) opposite the single leg (*c*), which also serves as a ladder by being provided with spikes (*s*). The rope-tackle (*f*, *p*) is similarly arranged to that seen in Model No. 10,503, and Plate VIII., figs. 5 to 7.

The drawing also exhibits a section of the boring-shaft, with the shod (R) surface-pipe (*b*), and the position of the men when in the act of turning the rods by the handle. (Scale: $\frac{1}{2}''$ to 1′.)

2nd. THE PRINCIPAL BORING INSTRUMENTS, as used for borings of small depth by either rotatory or percussive action; the greater part of them are represented in the models and the accompanying Plates, and described under the following numbers and letters:—

1st.—Models.

A = No. 10,747; Plate XIII., fig. 12.
B = No. 10,728; Plate XII., fig. 21.
C = No. 10,735; Plate XII., fig. 14.
D = No. 10,734; Plate XII., fig. 20.
E = No. 10,739; Plate XII., fig. 19.
M = No. 10,750; Plate XIII., fig. 13.
O = No. 10,738; Plate XIII., fig. 15.
H = No. 10,732; Plate XIII., fig. 10.
L = No. 10,726; Plate XIII., fig. 3.
I = No. 10,748; Plate XIII., fig. 14.
J = No. 10,749; Plate XIII., fig. 16.
P = No. 10,725; Plate XIII., fig. 4.
V = No. 10,746; Plate XV., fig. 12.
U = No. 10,727; Plate XIII., fig. 5.

2nd.—Sketches.

G = Plate XV., fig. 1.—(1″ to 1′.)
K = Plate XIII., fig. 8.—($1\frac{1}{2}''$ to 1′.)
R = Plate XV., fig. 13.—(1″ to 1′.)

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T = Plate XIV., fig. 19.—(1″ to 1′.)
Z = Plate XIII., fig. 19.—(1″ to 1′.)
N = Plate XIII., fig. 9.—($1\frac{1}{2}$″ to 1′.)
Q = Plate XII., fig. 2.—(1″ to 1′.)
S = Plate XIV., fig. 6.—(1″ to 1′.)
X = Plate XIV., fig. 13.—(1″ to 1′.)
W = Plate XI., fig. 16.—($1\frac{1}{2}$″ to 1′.)

F = ($1\frac{1}{2}$″ to 1′) *Square, pyramidal-pointed Chisel or Stone-breaker*; employed for the same purpose as the chisels, fig. 20 and fig. 7, of Plate XII.

EXPLANATION OF PLATES.

PART I.

ILLUSTRATIONS OF MODELS

REFERRING TO THE

EXPLORATION AND WORKING OF MINES.

§ A, *a* and *b*.

EXPLORATION OF THE SOIL.

(PLATES I TO XV.)

PLATE I.

HARZ MINING TOOLS.

(Figures 1 to 13.)

Figures 1, 1*a*. Mining Pick. (Spitzhammer.) 43.

2, 2*a*. Scraper. (Kratze.) 44.

3, 3*a*. Axe (3*a*., side view and section). (Bergaxt.) 53.

4, 4*a*. Trough (wooden). (Bergtrog or Mulde.) 54.

5. Crosscut Saw. (Bergsäge.) 52.

6, 6*a*. Dressing Hammer. (Erzfäustel.) 40.

7, 7*a*. Sledge Hammer. (Treibefäustel.) 41.

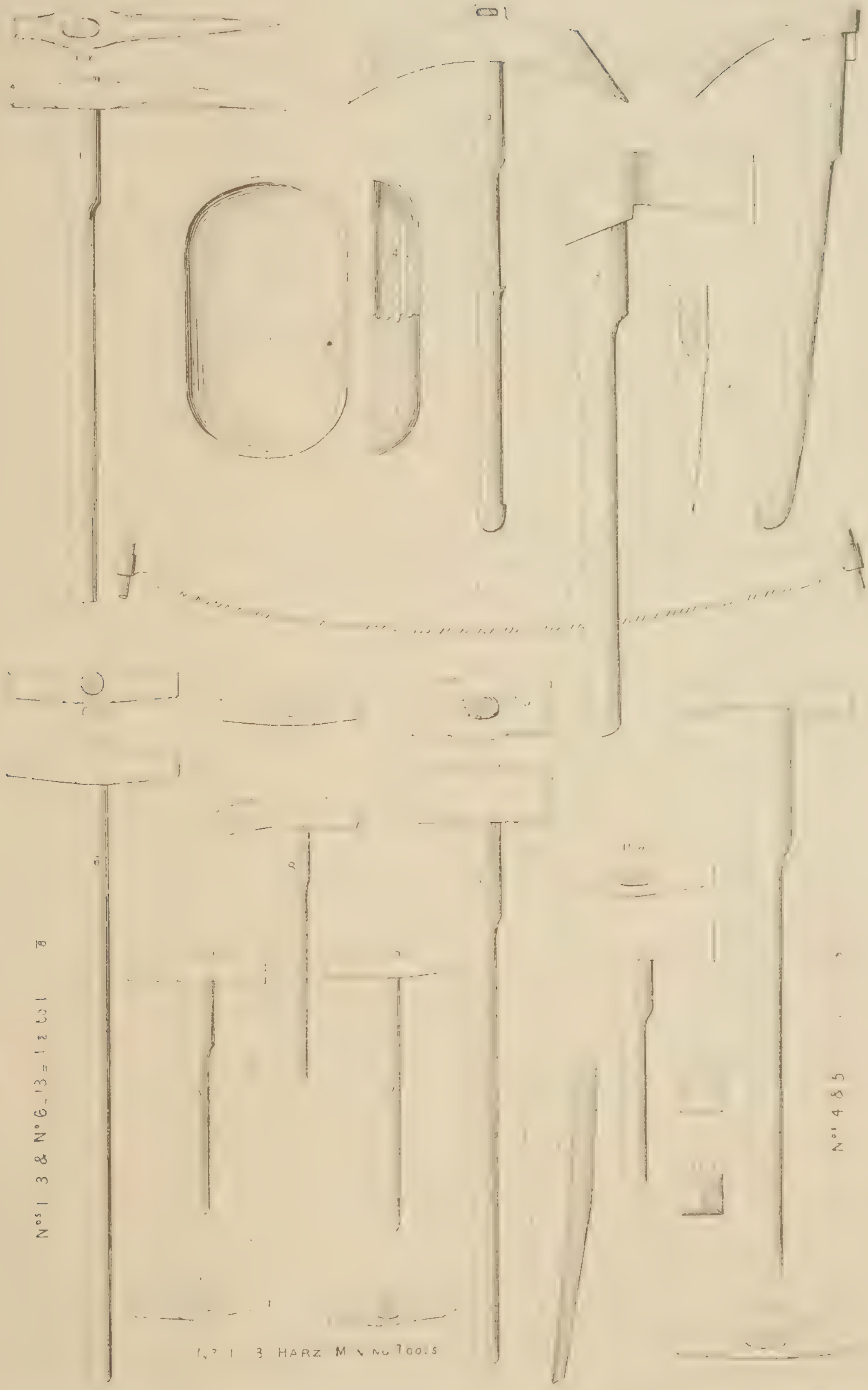
8, 8*a*. Single-handed Hammer. (Einmännisches Bohrfäustel.) 46.

9, 9*a*, 11, 11*a*. Dressing Hammers. (Scheidehämmer.) 47 and 48.

10, 10*a*. Small Gadze, with handle. (Bergeisen.) 49.

12, 12*a*. Double-handed Hammer. (Zweimännisches Bohrfäustel.) 45.

13, 13*a* and *b*. Large Gadze. (Fimmel.) 42.



3 HARZ M Tools

PLATE II.

HARZ MINING TOOLS.

(Figures 1 to 14.)

(*a*) TOOLS FOR DRILLING HOLES BY TWO MEN. (ZWEIMÄNNISCHES GEZÄHE.)

Figures 1 to 3. Set of Borers, or Drills. (Meisselbohrer.) 28 to 30.
3, 3*a*. Side view and section of same.
4, 4*a*. Cross-borer. (Kolbenbohrer.) 27.
5, 5*a*. Iron Tamping Bar. (Stampfer.) 33.
6, 6*a*. Iron Scraper. (Krätzer.) 31.
7, 7*a*. Blasting Needle. (Schiessnadel.) *See* Plate VII., 32.

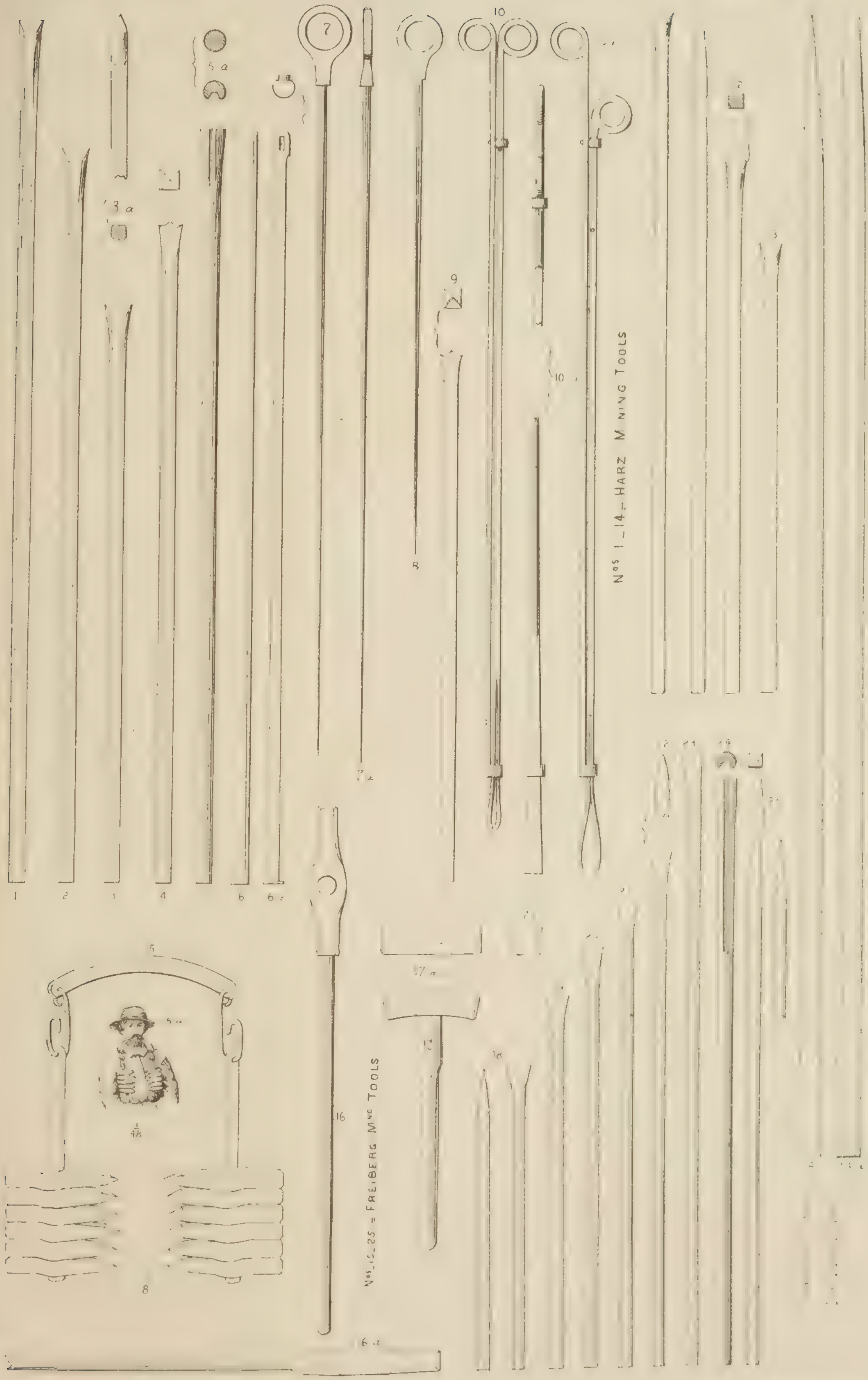
(*b*) TOOLS FOR DRILLING HOLES BY A SINGLE MAN. (EINMÄNNISCHES GEZÄHE.)

Figure 8. Blasting Needle. (Schiessnadel.) 38.
(For Tamping Bar, *see* Figure 24.)
9. Cross-borer. (Kolbenbohrer.) 34.
10. Pair of Forceps, withdrawn. (Bohrkluppe). 50.
10*a* and *b*. Pair of Forceps, opened.
11 to 13. Set of three Borers or Drills. (Meisselbohrer.) 35 to 37.
14, 14*a*. Crowbar. (Brechstange.) 51.

FREIBERG MINING TOOLS.

(Figures 15 to 25.)

Figure 15. Set of twelve Gadzes (Bergeisen) (H), arranged for carrying them over the shoulder. (*See* figure 15*a*.)
16, 16*a*. Claying Iron. L.
17, 17*a* and *b*. Single-hand Hammer. B. (Einmännisches Fäustel.)
18 to 23. A set of six single-hand Borers. A. (Einmännische Bohrer.)
24. Single-hand Tamping Bar. D. (Einmännischer Stampfer.)
25 Jumper. C. (Schraemspiess.)
(For Needle and Scraper, *see* figures 6 and 8.)



B. Straubel del.   Prof. M. Cox direxit

PLATE III.

CORNISH MINING TOOLS.

(Figures 1 to 9.)

Figures 1, 1*a*. Poll Pick.

2, 2*a*. Cobbing Hammer (dressing tool).

3, 3*a* and *b*. Double-hand Boring Hammer, or Mallet.

4, 4*a*. Bucking Hammer, or Bucker.

5. Gadze.

6, 6*a*. Jumper.

7, 7*a*. Scraper, with scoop and disc.

8, 8*a* and *b*. Set of three Borers, or Drills.

8*c* and *d*. Side view and section of same.

9. Iron Tamping Bar.

ENGLISH COAL-MINING TOOLS.

Figures 10, 10*a* and *b*. Tamping Hammer.

11, 11*a* and *b*. Double-hand Boring Hammer.

12, 12*a*. Coal-Mining Gads.

13. Blasting Pricker.

14. Stone Drill.

15, 15*a* and *b*, 16. Coal-Mining Drill Borers.

PLATE IV.

ENGLISH COAL-MINING TOOLS.

(Figures 1 to 6.)

Figures 1, 1*a*. Coal Pick, or Mandril (Cutting Mandril).
2, 2*a*. Coal Pick, or Mandril (Cutting Mandril).
3, 3*a*. Stone Pick (Holing Mandril).
4. Cornish Swabbing Stick.
5, 5*a*. Tamping Bar.
6. Scraper.

VICTORIAN QUARTZ-MINING TOOLS.

(Figures 7 to 14.)

Figures 7, 7*a* and *b*. Single-hand Boring Hammer. 5.
8. Gadze. 3 and 4.
9, 9*a* and *b*. Sledge Hammer. 6.
10, 10*a*. Sinking Poll Pick. 1 and 2.
11. Iron Shaft Bucket. 9.
12. Ear Safety Hook, closed. 9.
12*a*. Ear Safety Hook, opened. 9.
13. Drill. 8.
14. Jumper. 7.

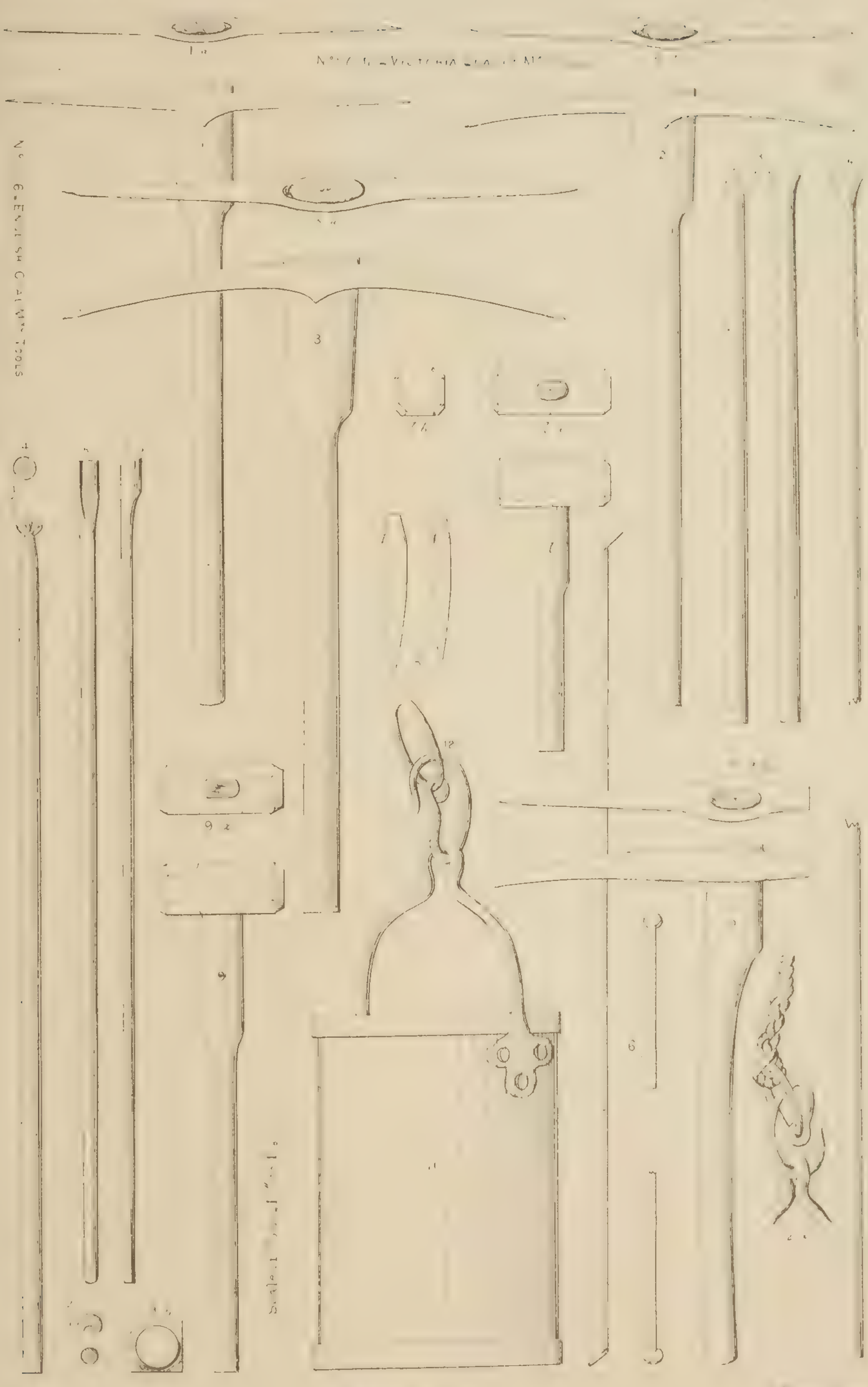


PLATE V.

VICTORIAN GOLD-MINING TOOLS.

QUARTZ.

Figures 1, 1*a*. Quartz-Mining Pick. 2.

ALLUVIAL.

Figures 2, 2*a*, 4, 4*a*. Miners' Sinking Picks. 1 and 2.

3, 3*a*. Miners' Driving Pick. 4 and 5.

5 and 6*b*. Paddocking or Cornish Shovel. 9.

6, 6*a* and *b*. Sinking Shovel. 3.

7, 7*a*. Cradler's Dipper. 8.

8, 8*a*. Prospecting Dish. 7.

9, 9*a*. Goldwasher's Riddle. 6.

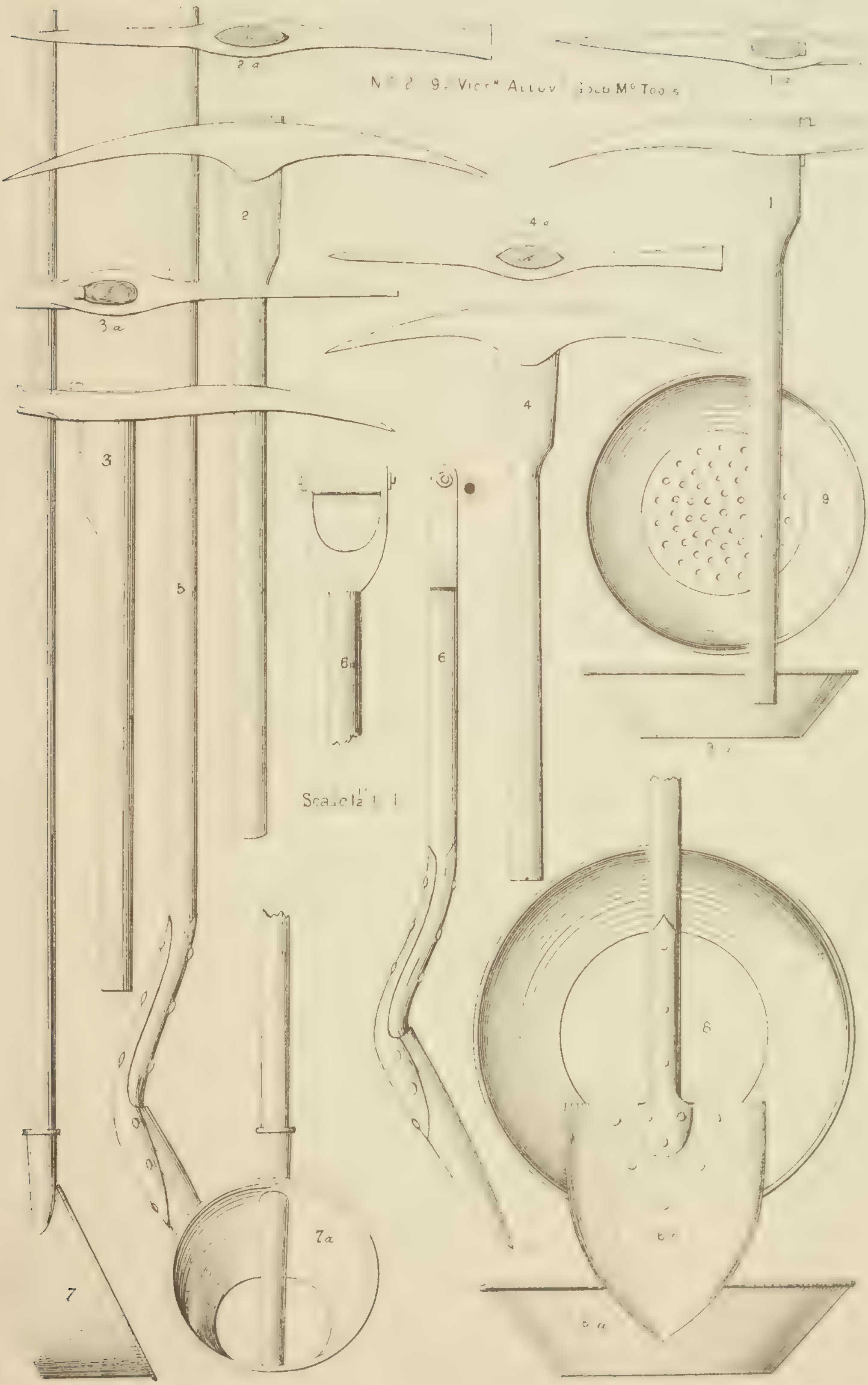


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PLATE VI.

SCHUMANN'S PORTABLE BORING MACHINE.

WORKED BY MEANS OF COMPRESSED AIR.

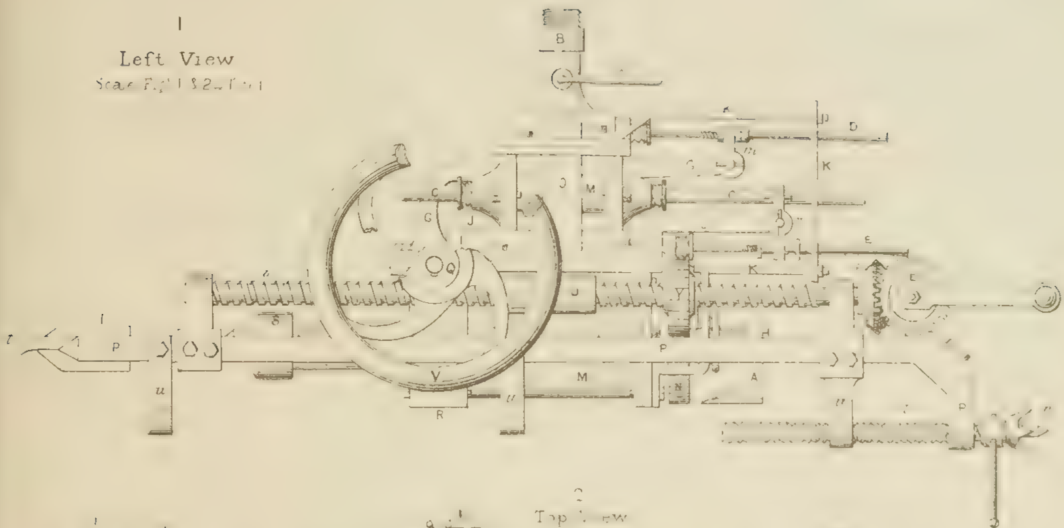
Figure 1. *Left-side Elevation.*—P, *frame;* U, *stationary screw* for driving the machine; M, *boring-cylinder;* Y N, *spur-wheels* of *driving gear* for advancing motion; A, *driving-tooth* on end of back rod (*g*) of piston (Z); F E, *bevelled hand-gear* for working the screw (U); V, *fly-wheel;* Q, *crank-axle;* J, *crank-rod* (working piston D); G, *excentric-rod* (working the pistons C and E′); *m*, *adjusting-block* (connecting G with D); *n*, *adjusting-block* (connecting J with C and E′); K, vertical *framework* (for support of pistons D, C, and E′); M′, *working-cylinder;* O, *air-passage;* B, *neck of machine* (air entrance); *d*, *valve-handle;* P *p*, *screw-chuck;* *u*, frame-ties.

2. *Top View.*—H, *worm-screw;* R, *box* containing *worm-wheel* (L); S, *front rod* of boring-piston (Z); *t*, *boring-drill;* I, *adjusting screw-chuck;* J, *crank-rod;* G, *excentric-rod.* Rest of lettering coinciding with those of figure 1.

3. A *sketch* representing a position of the boring machine on the face of a drive.

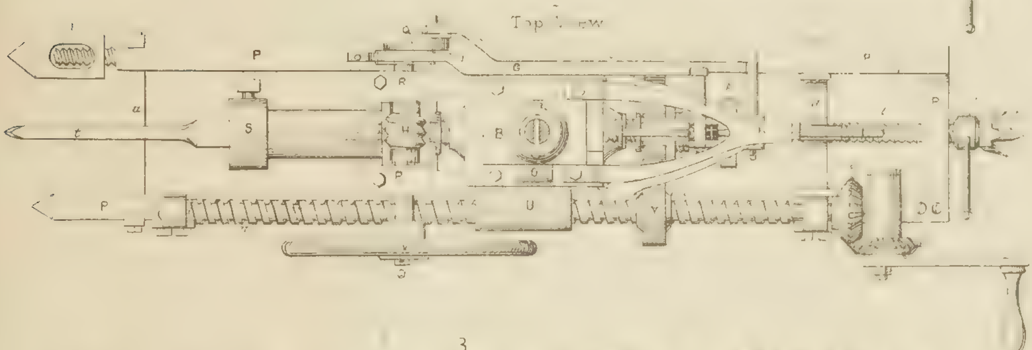
1

Left View



2

Top View



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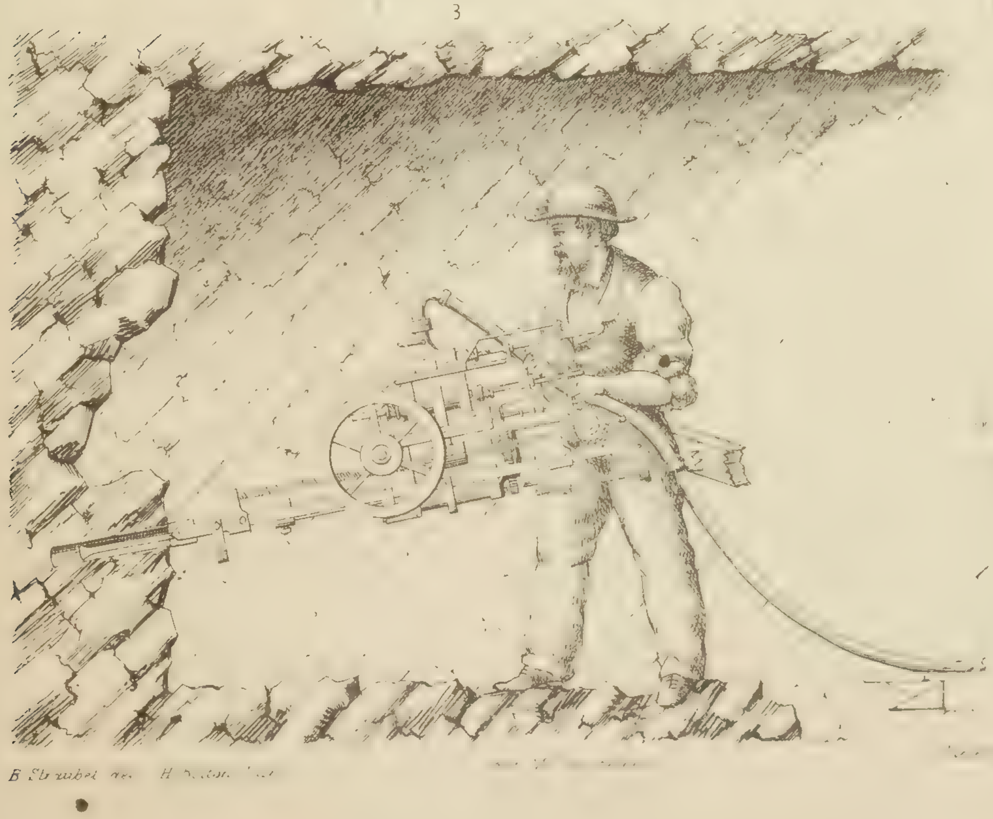

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PLATE VII.

SCHUMANN'S PORTABLE BORING MACHINE.

WORKED BY MEANS OF COMPRESSED AIR.

(Figures 1 to 6. Continuation of Plate VI. Lettering the same in all the figures).

Figure 1. *Partial Back View*, showing the connexion of the *driving gear* (Y N) with the *stationary-screw* (U) and the *boring-cylinder* (M); A, back view of *driving-tooth*: P, section of *frame-bars*.

2. *Back View*, without crank gear (G J) and driving gear (N Y); E F, bevelled hand-gear: *i*, screw-chuck; P, back part of frame.

3. *Front Elevation*, with sectional view of box (R) containing the worm screw gear (H L).

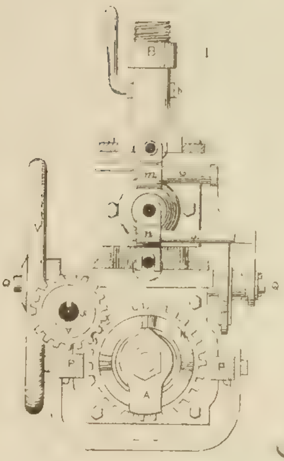
4. *Longitudinal Section* through centre of whole machine.

5. *Cross Section* through middle of cylinders (M′ M), and the feeding-pipe (B).

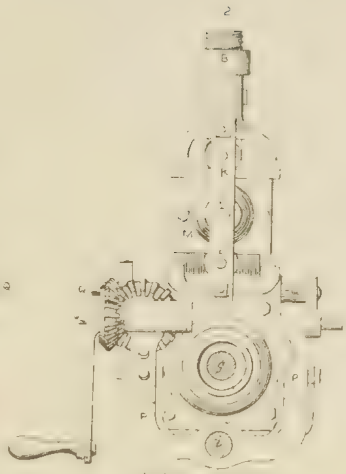
6. *Right-side Elevation.*—J, crank-rod; G, excentric-rod; C, piston of working cylinder (M′); D E, respective rods of slide valves (W E): U, stationary-screw; M, boring-cylinder; V, fly-wheel; S, boring-piston, &c.

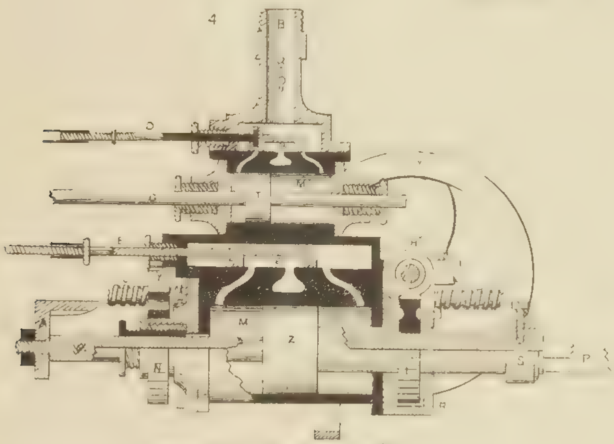
7*a*. *Section of a Borehole*, partly loaded, showing the use of the needle inserted into the cartridge.—R, needle; *d*, cartridge; *e*, tamping.

7*b*. *Section of a Charged Borehole* (prepared according to the method used in the Harz and Saxon mines) ready for being fired off by means of the peculiar touch-paper (Schwefel-männchen) (*s*).—*e*, tamping; *d*, powder charge.

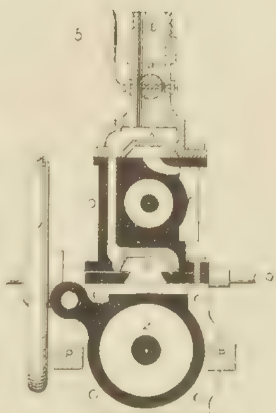


Partial Back View

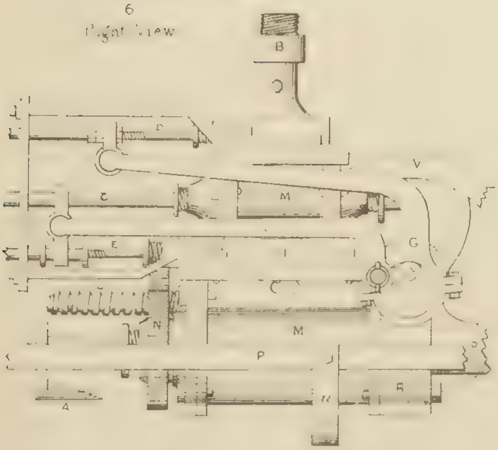




Longitudinal Vertical Section



6
Right View



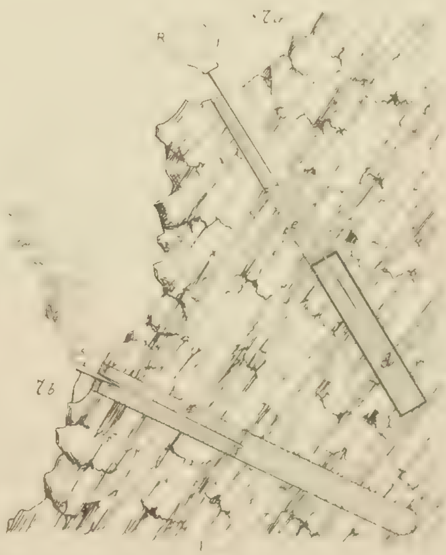


PLATE VIII.

EARTH-BORING.

FIGURES 1 TO 4, AND 17.—APPARATUS FOR BORING WITH THE TREAD-WHEEL, OR STEAM OR WATER-POWER.

Figure 1. *Side Elevation.*—W, tread-wheel; S, wheel-axle; H, boring-shaft; R, boring-drum; U, stool-frame to support S; V, ground-sleepers; L, boring-lever; Q, wooden spring; T T′, frames to support L and Q respectively; *t t′*, pins to support L; N, recoiling block; P, recoiling post; D, boring-swivel; *d*, axle of lever L.

2. *Top View* of figure 1.—*a*. four lifting-rollers.

3. *Horizontal Section* and *Top View* of rope-drums (F), and the boring-drum (R), and the outrigging gear (Y *i b g*).

4. *Side Elevation* of figure 3.—Y, handle of outrigging gear; V, fixed clutch-boxes.

17. *Vertical Cross Section* through boring-drum.

FIGURES 5 TO 7. PORTABLE BORING-TOWER, IN CONNEXION WITH A BORING AND WINDING APPARATUS, WORKED BY HAND.

Figure 5. *Side Elevation.*—A, tower; D, four corner timbers or poppet-legs of A; E, mean-bearers of D; G, horizontal ties; H and F, main pulley and block of tackle; W, windlass; J T, frame for supporting W; *t*, four winch-horns; O, ground-sleepers of tower; S, boring-shaft; Q, wooden spring; L, boring-lever; T T′, respective frames for Q and L; N, lever-handle; K, surface of ground.

6. *Partial Top View* of tower A (fig. 1).

7. *Top Views* of spring (B), lever (L), shaft (S), windlass (W), and ground-frame (E) of tower A.

FIGURES 8 AND 9. FRONT AND SIDE ELEVATION OF A HAND BORING-APPARATUS, WITH SPRING AND LEVER IN ONE FRAME.

Figures 8 and 9. L, boring-lever; M, lever-handle; P, hook for suspending the boring-rods; N, wooden spring; T R Q C, framework for reception of spring and lever; *i e*, four pairs of wedges for fixing the spring N.

FIGURES 10 TO 12. HAND BORING-APPARATUS FOR BORING HORIZONTAL AND INCLINED HOLES BY PERCUSSION.

Figure 10. *Longitudinal Section.* A B C, framework; H, roller for supporting the boring rods (J); E, block at the end of boring-rods; F G, guide-rollers; P, screw-bolt, for fastening the rope *i*, suspending the counterweight D; *r*, handle of D; L, working rope; M, windlass; S, braces; K, stage-frame, for support of guide-bearing *e*.

11. *Vertical Cross Section* through middle of apparatus (looking towards windlass).

12. *Vertical Cross Section* through middle of apparatus (looking towards the bore-hole).

FIGURES 13 TO 16. HAND BORING-APPARATUS FOR BORING HORIZONTAL OR INCLINED HOLES, BY ROTATORY ACTION.

Figure 13. *Longitudinal Section.*—A B C, boring-stage; R, boring-rod; H, roller to support the rods; S, guiding-pins; E, cross-handle.

14. *Front View.* 15. *Back View.* 16. *Cross-handle.*

FIGURES 18, *a*, *b*, *c*.—KIND'S WOODEN BORING-RODS—(MAXIMUM SCALE).

Figure 18*a*. *Vertical Sections* of portions of the rods.—R, wooden rod; H, conical socket of octagonal head (V); S, conical sheet-iron tube; *e e*, iron pins; W, wooden wedge; *m*, middle rod-joint.

18*b*. *Elevation of two Joined Rods.* 18*c*. *Horizontal Section.*

FIGURES 20 TO 22. THREE DIFFERENT MODES OF JOINING IRON RODS BY THE HALF-LAP AND TONGUE-JOINT.

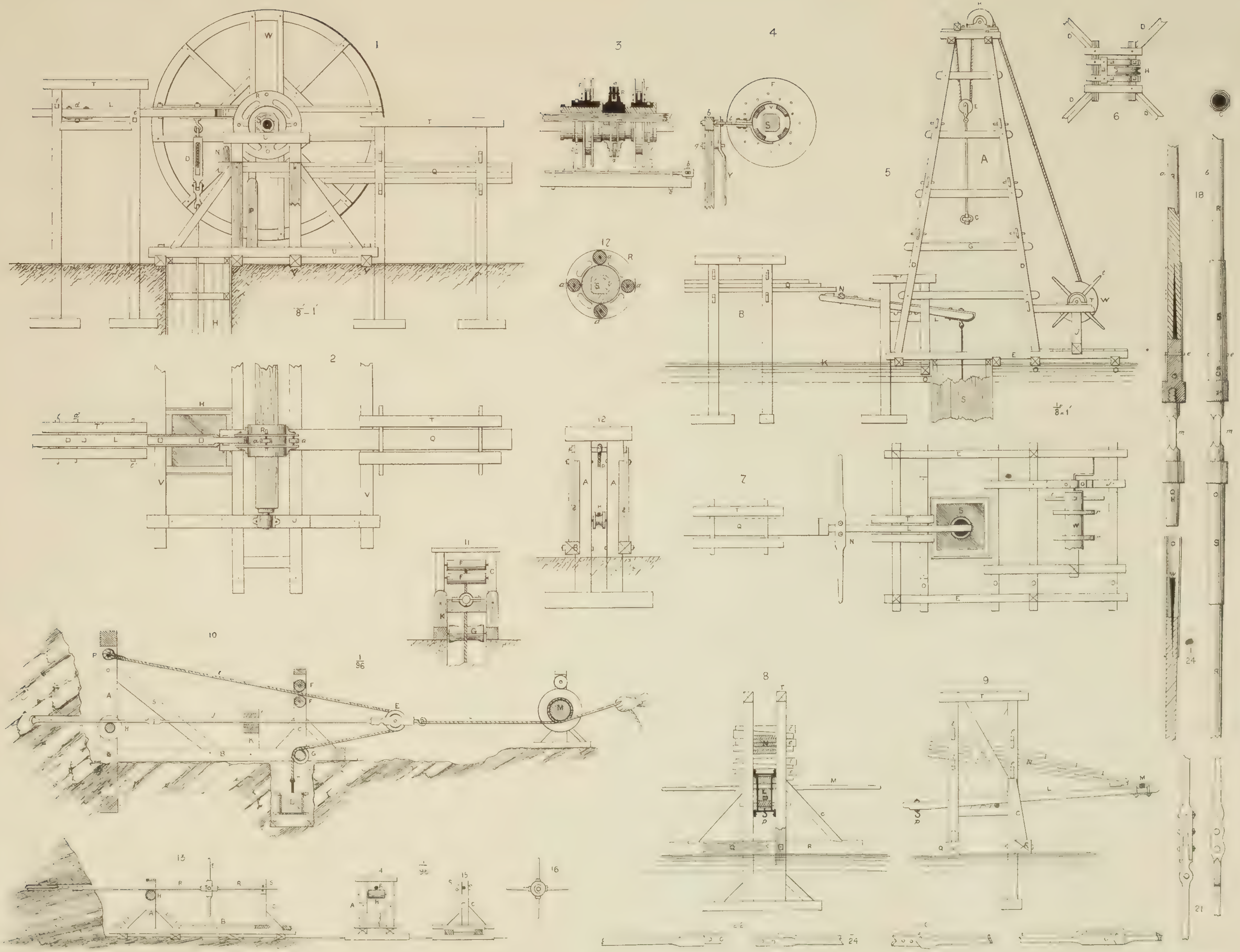


PLATE IX.

EARTH-BORING.

FIGURES 1 TO 7.—DEGOUSÉE'S HAND BORING-APPARATUS, FOR BORING HOLES FROM 350 FEET TO 800 FEET IN DEPTH.

Figure 1. *Side Elevation.*—H A, principal frame-timbers of tower; B, ground-sleepers; D, boring-lever; C, bearer to support D; *d*, cross-braces; *x*, hook to suspend the boring-chain; *w*, lever-axle; *e*, axle-straps; *r*, forked end of armor-plate of lever D; *t*, single-armed lever in gear with cam-wheel (N) of windlass (W); *z*, iron swivelled rod, connecting the levers D and *t*; *a*, pulley of winding-gear; Q, lever-beam, with counter-weight P, for balancing the upper portion of boring-train; *b*, strap to suspend P; U G, stool-frame to support the balance-bob; V T, stool-frame to support and guide lever *t*; F, boring-handle; Y, top joint of rods.

2. *Front Elevation* of fig. 1.

3. *Partial Top View* and *Ground Plan* of fig. 1.

4. *Top View* of forked end (*r*) of armor-plate on lever D.

5. *Front View* of windlass gear.—J, iron-plated barrel; R S, driving-wheel and pinion; N, cam-wheel.

6. *Side View* of fig. 5.

7. *Longitudinal Section* through cam-wheel (N) and barrel (J) of fig. 5.

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8. *Degousée's small portable Poppet-heads*, for boring holes from 45 to 100 feet in depth.—P, pulley; J, framed front legs; L, hinged leg; F, step-ladder on L; *e*, tie-bolt at junction of three legs; N, triangular ground-frame.

9, *a* and *b*. *Top and Side View* of an iron clamp (a safety contrivance); *c*, screw-bolt to work the hinged plates.

10, 11. *Keys*, for screwing on, detaching, and supporting rods.

12. *Front View* of a boring-swivel and double-eyed boring-handle.—L, eye at top of screw to suspend the swivel J; N, screw-guide; H, universal-joint; T and F, boring-handles; E, female screw-socket.

13. *Side Elevation* of fig. 12.

14, 15. *Top and Side Views* of a boring forceps, hinged to the iron cap of the surface-pipe.—S, two wrought-iron plates of forceps; K, iron cap of surface-pipe P; *i*, hinge-bolts; *e*, steeple-lock; *n*, square opening for the passage of the rods (R).

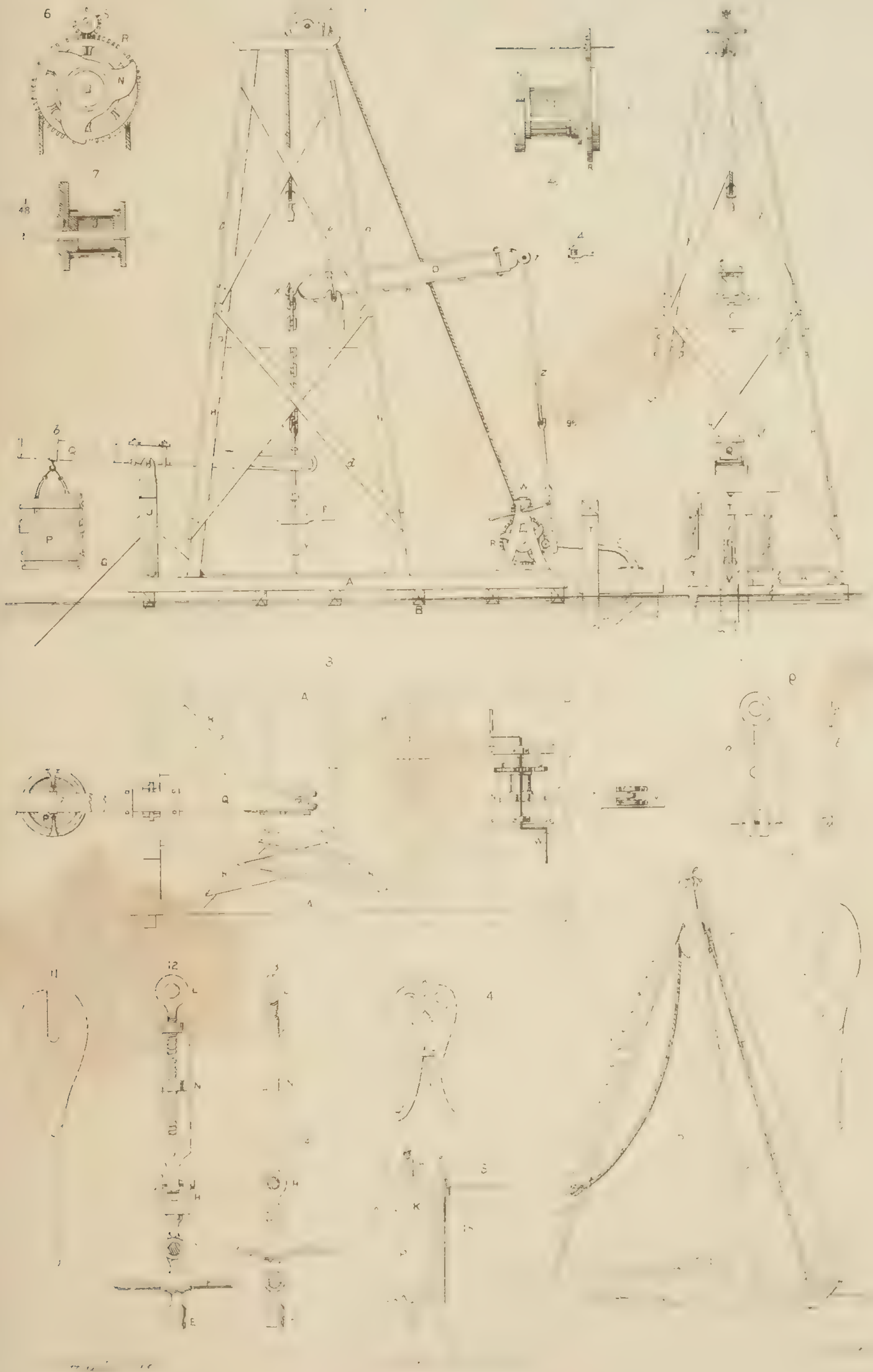

PLATE X.

EARTH-BORING.

FIGURES 1 AND 2. SIDE AND FRONT ELEVATION OF THE SURFACE PORTION OF A HAND BORING-APPARATUS IN CONNEXION WITH CORRESPONDING VERTICAL SECTIONS OF THE BORE-SHAFT, WHICH CONTAINS A SCREW-JACK, EMPLOYED FOR THE INTRODUCTION OF TUBES.

Figure 1. *Overground.*—T, F, Q, J, ground-sleepers, upright stool-frames, axle-bearers, and braces of boring-stage; C B, boring-lever; D, boring-chain: *i*, pull-strings; L, step-ladder; E, suspended boring-rod; A, pulley; R Y, windlass; H, rope of winding gear; S, stage for men working the windlass; W, mouth of timbered shaft.

2. *Underground.*—A R T, frame-work of screw-jack; *e e*, screws; V, collar on top of pipes, made to travel up and down the screws; C, guiding-tube; P L, columns of tubes to be introduced; J, stages in shaft W.

FIGURES 3 TO 5. DIFFERENT VIEWS AND SECTIONS OF A NEW SCREW SOCKET-JOINT.

Figure 3. Bottom of male socket (*e*).

4. Joined sockets, with sectional view of female socket (*s*).

5. *Top View* of female socket (*s*).—*a*, eight pin-holes in flange of female socket; *d*, pin-hole in flange of male socket; *i*, screw of male socket: *p*, tie-pin or bolt.

6. *Horizontal Section* through the tubes C and P.

7. *Top and Side View* of collar (V) of the screw-jack.

8–10. *Front, Side, and part of a Perspective View* of a portable, easel-shaped tripod, for rotatory borings.—T, framed legs; F and E, top and bottom rail; S, hinged leg; L, T-shaped axle-bar of S; *i*, strap for suspension of block; W, windlass; *t*, iron hasps; *d*, iron horizontal working lever; R, surface-pipe.

11, *a*, *b*. *Two Keys* for detaching the rods.

12. *The Crow's Foot.*—F, swivelled handle; A, foot to support the rods.

13. *Head-joint and Swivel*, for working the mud-pump.—S, female socket of joint. Elevation and sectional view.

14. *The Scotch*, for supporting and unscrewing rods.

15. Kind's swivelled *Handle-joint*, for deep borings.—*a*, swivelled eye, connected with the rope; *b*, swivelled handle, screwed to the top-rod *c*.

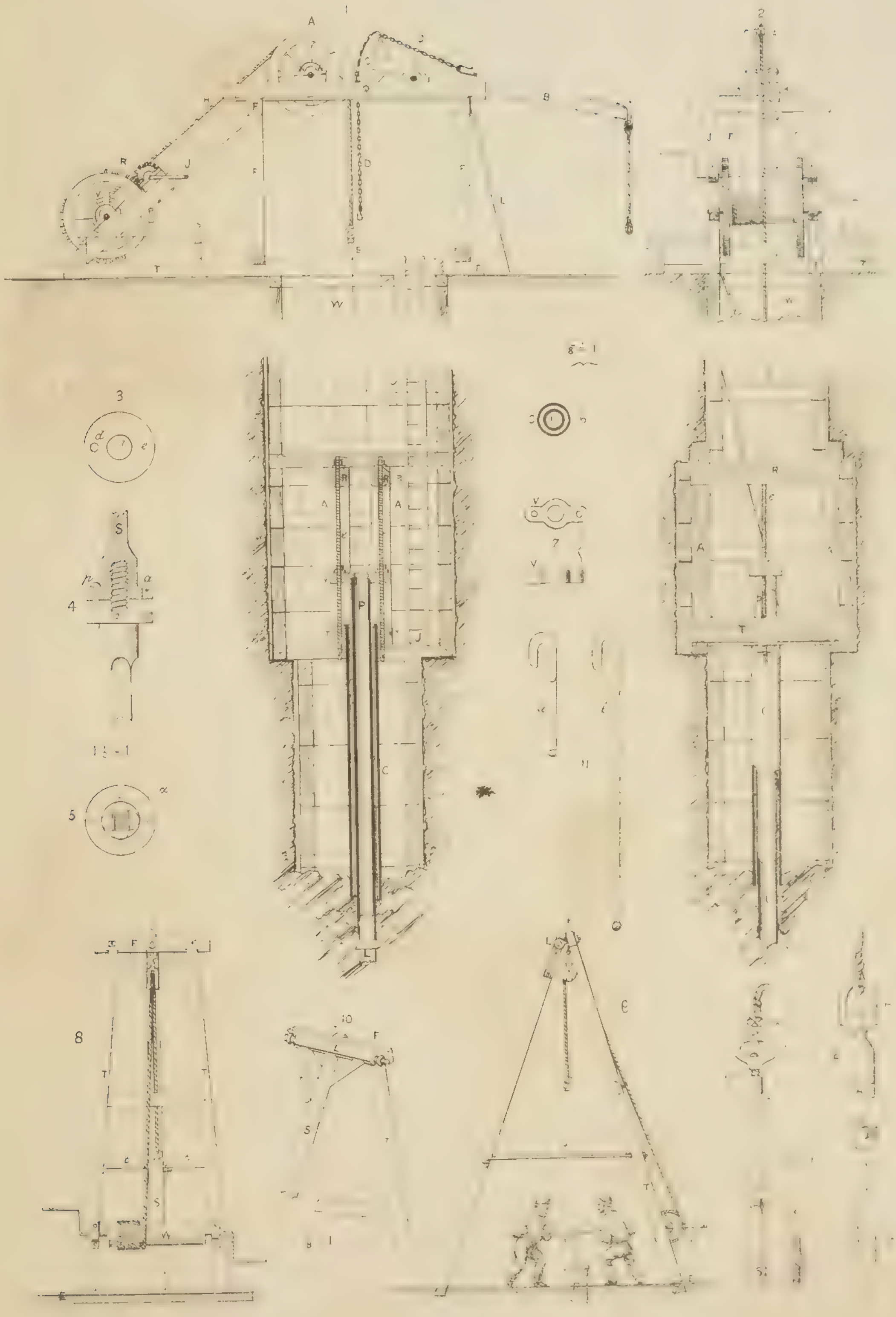

PLATE XI.

EARTH-BORING.

Figure 1. *Wrought-iron Square Boring-rod*, for wide and deep borings.—1 *a*, bottom view; 1 *b*, cross sections above and below the square collar.

2, 2 *b*. *Wrought-iron Square Boring-rods*, joined together, for narrow and shallow borings, &c.—2 *a*, socket-joint of the two rods; 2 *c*, top view and cross section.

3, 3 *b*. *A pair of Wrought-iron Square Boring-rods*, for deep borings, with long sockets provided with corresponding key-faces cut into each of them.—3 *a*, socket-joint; 3 *b*, vertical section of lower or female socket; 3 *c*, top view and cross section of figure 3.

4. *French (Degousée's) heavy Boring-rod*, with a short female socket below, and a long key-faced male socket above (with side view and section of lower socket).

5, 5 *a*. *Degousée's Sheet-iron Tubular Boring-rods*, with wrought-iron tubular sockets, and joined together by means of a key and the usual screw.—5, sectional view; 5 *a*, full side view; 5 *b*, top view and horizontal section.

6. *Degousée's Iron Tubular Boring-rod*, with solid socket shafts, bolted and keyed together.—Full side view and vertical section.

7. *Degousée's Wooden Boring-rod*, for deep and wide borings.—Full side view and vertical section.

8. *Kind's Main Octagonal Boring-rod*, in connexion with the boring-tool (*see* fig. 18).—Y, octagonal portion of rod; *c*, round part of rod for the reception of guide; 8 *a*, side view; 8 *b*, top view; 8 *c*, section of the lower socket part of the rod, attached to the chisel.

9. *Wooden Cylindrical and Sliding Parachute*, as employed in deep and wide borings.—H, wooden cylinder; 9 *a*, top view.

10. *Hood-shaped and Sliding Parachute*, of leather.—10 *a*, top-view.

11. *Kind's Sliding-joint*, for heavy borings, with its shaft (F) containing the slot, attached to the main rod (Y) by a female socket.—E, upper forked portion of sliding-joint; 11 *a*, side view and section of lower socket.

12. *Kind's Sliding-joint*, as employed in direct connexion with the mud-pump (fig. 15).—L, forked upper portion of sliding-joint; H, lower portion, containing the slot; 12 *a*, side view.

13. *Spring Guide*, attached to the round part (C) of the main rod (14 Y), for guiding the lower portion of the boring-train; 13 *b*, vertical section of guide.

11, 13, and 14.—Arranged in successive order.

15. *Sheet-iron Cylindrical Mud-pump, with Clack*, as usually employed, in connexion with the sliding-joint, for cleaning a bore-hole (fig. 12) —15 *a*, side view and section; 15 *b*, top view.

16. *Sheet-iron Cylindrical Mud-pump, with Bullet-valve*, worked without the sliding-joint by a rope attached to its handle.—16 *a*, vertical section of lower part of pump; valve shut; 16 *c*, vertical section of lower part of pump; valve open; 16 *b*, top view.

17. *Bell-shaped Chisel*, for widening and trimming a bore-hole —17 *a*, top view.

18. *Large Chisel*, with wing-cutting edges, in connexion with the crown chisel (fig. 19), and the main rod; lower part (8 *c*).—18 *a*, side view, showing the square neck on which the crown chisel (19) is fixed; 18 *b*, top view.

19. *Crown Chisel*, attached to the square neck below the screw-head of a chisel (18), for the purpose of trimming and enlarging a bore-hole.—Z, four blades; 19 *a*, top view; 19 *b*, vertical section through middle and opposite blades.

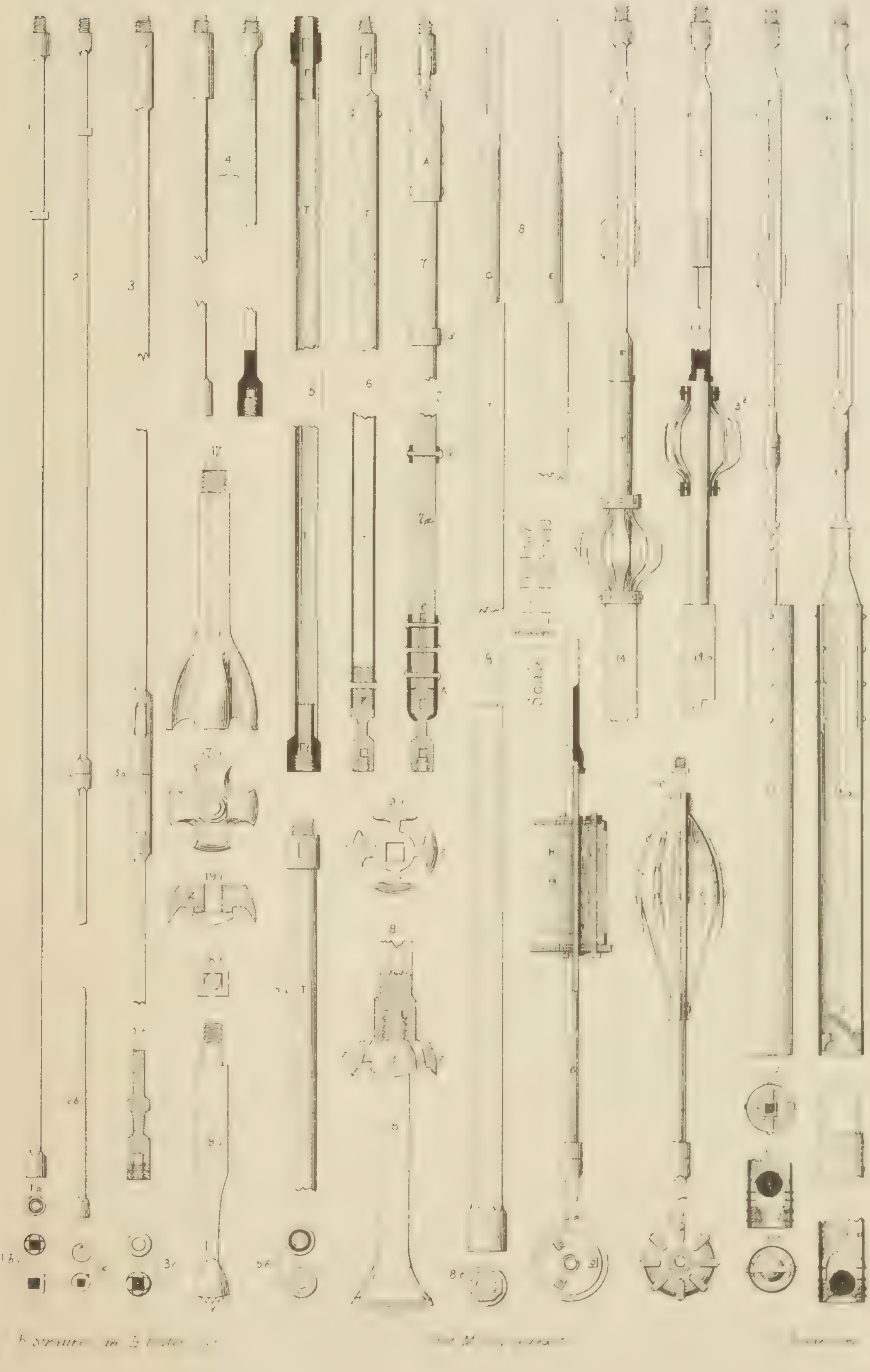

PLATE XII.

EARTH-BORING.

Figures 1 and 2. *Wrought-iron Boring-rod and Chisel*, as employed in Chinese boring with the rope; with bottom views.

3. *Large Chisel*, with changeable blades, according to size and condition of a bore-hole.—*3a*, side view of lower part of shaft and its inserted blade.

4. *Ordinary Chisel*, with a long auxiliary centre or head blade for wide borings.—*4a*, side view.

5. *Triple-edged Chisel*, with projecting central blade and wing blades on both sides, forged in one piece.—*5a*, side view; *5b*, bottom view.

6. *Ordinary Single-edged Chisel*, provided with wing blades on one side only.—*6a*, side view.

7. *Cross-edged Chisel*, or Stonebreaker (Casse Pierre), with bottom view.

8. *Triple-edged Chisel*, with projecting side blades.—*8a*, vertical central section.

9. *Conical Ring Chisel*, for trimming and widening bore-holes.—*9a*, top view.

10. *Toothed Ring Chisel*, for trimming and widening boreholes.—*10a*, bottom view.

11. *S-shaped Chisel*, with alternating wing blades.—*11a*, bottom view.

12. *Boring Instrument*, for boring a core.—*12a*, bottom view.

13. *Small Triple-edged Chisel*, with projecting centre or head blade, forged in one piece.—Front and side view, without wing blades.

14. *Crown* or *Cross Borer*, for enlarging and trimming small bore-holes; with bottom view.

15. *Ordinary Single Chisel*, for boring small holes; with side view.

16. *Boring-tool*, with two wing blades, as used in connexion with a plain triple-edged chisel (13, 3, 4), for enlarging and trimming a bore-hole; blades of trimmer set obliquely to those of the chisel below.—*16a*, side view.

17. *Kind's Shear Borer*, or Hinged Chisel, used to enlarge holes for the passage of tubes.—*17a*, side view.

18. *Ordinary Chisel*, for wide borings.—*18a*, side view.

19. *Oblique-edged Chisel*, for small borings.—*19a*, side view.

20. *Pyramidal Chisel*, or Stonebreaker, with bottom view.

21. *Conical Borer* (mitre, bonnet de prètre or étoile), for bedding tube ends; also used as a breaking-tool. With top view.

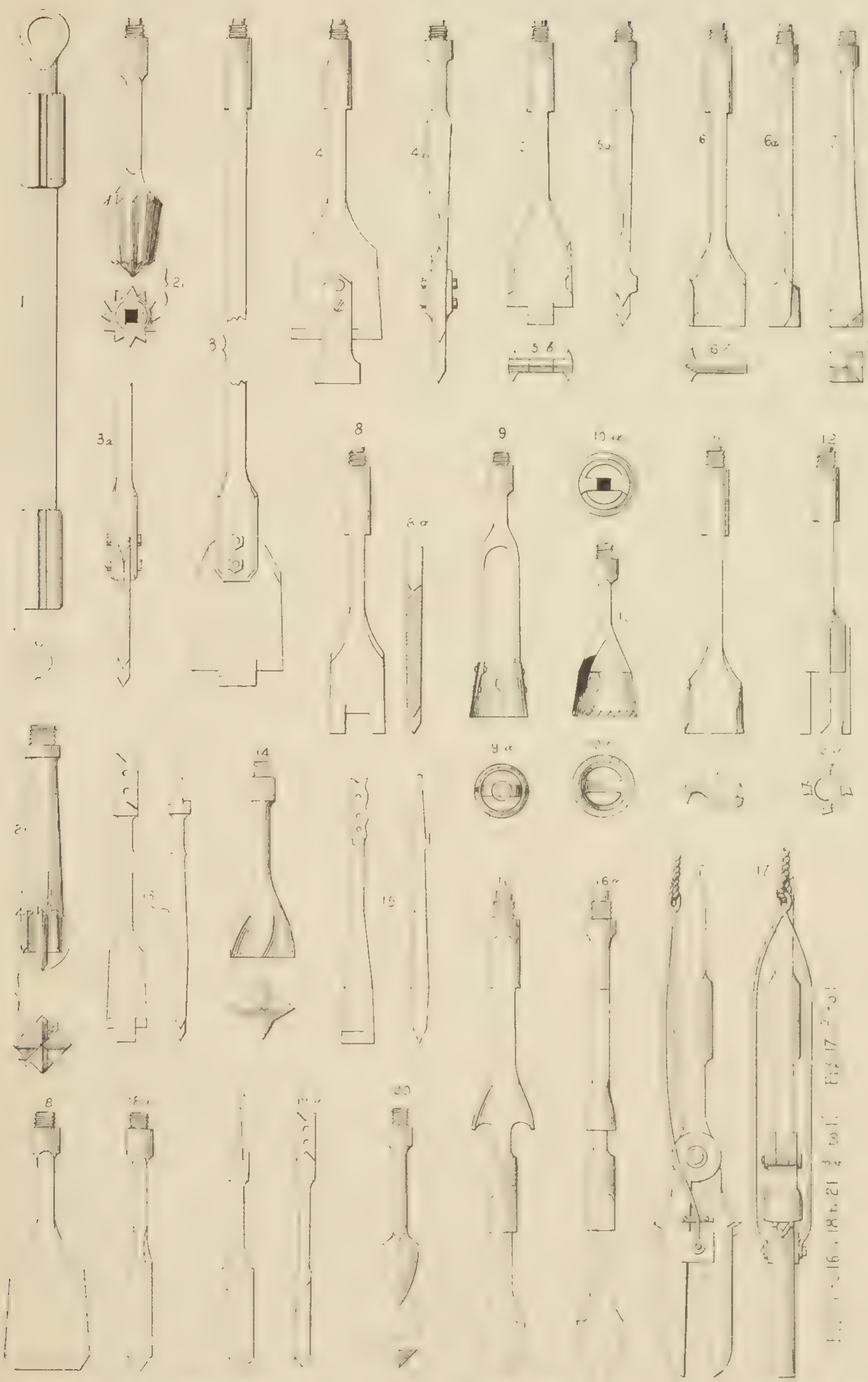

PLATE XIII.

EARTH-BORING.

Figure 1. *Spring Chisels*, for widening a hole underneath the pipes.—1*a*, side view; 1*b*, view of the casing, containing the chisels, with the lid taken off.

2. Instrument for extracting cores bored with the chisel, fig. 12, Plate XII.; with a horizontal section through hooks.

3. *Large, open, Cylindrical Auger*, with an inclined flat tongue and heel, making an angle with its mantle.—Front and side view; 3*a*, horizontal section.

4. *Large, closed, Cylindrical Auger*, with curved tongue and horizontal heel.—Front and side view; 4*a*, horizontal section.

5. *Large, closed, Cylindrical Auger*, with curved tongue and a double set of clacks.—15*a*, horizontal section through middle.

6. *Cylindrical Auger* of a small diameter, large opening, round tongue and short heel.—6*a*, horizontal section.

7. *Degousée's English Auger.*—7*a*, horizontal section.

8. *American Tongue* or *Serpentine Auger.*

9*. *Pricker*, for breaking ground.—Front view and horizontal section through shaft.

10. *A Clay-cutter.*—Front and side view.

11. *Cylindrical Clay-shell.*—Front view and section through shaft.

12. *Rotatory Tool*, for widening a hole under the pipes; also used for lowering pipes.—12*a*, horizontal section.

13. *Triangular Clay-cutter.*—Front view and horizontal section through shaft.

14. *The Clay-spoon.*—Front and side view; 14*a*, horizontal section through spoon.

15. *The Sack-borer;* used in drift or flowing sand.

16. *The Sand-funnel* or *Diver;* used in drift or flowing sand.—16*a*, vertical section. (Erroneously marked fig. 9 on the plate.)

17, 17*a*. *A pair of Wooden Pipes*—Full and sectional view, showing the mode of joining them.

18. Mode of joining wooden pipes of large dimensions.—Full and sectional view.

19. *A Wooden Ram-head.*—Sectional view; also a section showing the mode of shoeing the head tube.

20 to 24. Full and sectional views of four different modes of forming and joining wrought-iron pipes, viz.:—Figs. 20 and 21. *Collar-joints;* all joints riveted together; fig. 22. *Coupling of Conical Pipes*; all the joints riveted together; fig. 23. *Telescope-joint*, or coupling with long collars; fig. 24. *Pipes* soldered and coupled by a lock collar-joint.

* By error the Conical Sand-funnel, fig. 16, is also marked 9 and 9*a* on the plate.

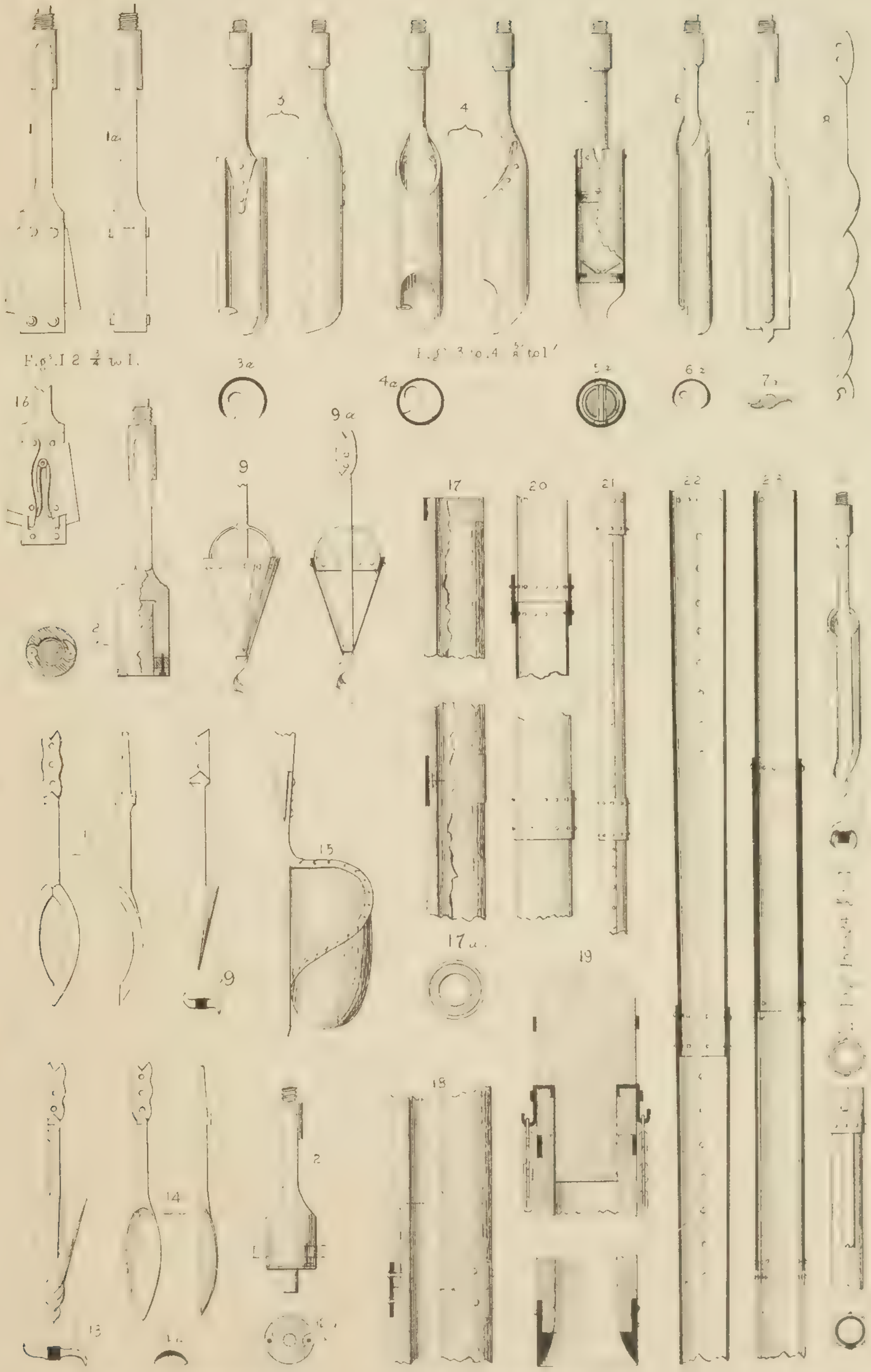

PLATE XIV.

EARTH-BORING.

Figure 1. *Wooden Vice*, for suspending pipes in a hole.—1*a*, vertical section and side view.

2. Mode of shoeing the end of a wooden pipe.—Vertical section and side view.

3. Instrument for the extraction of detached iron pipes, in a hole, the collars of which are slit for the reception of portions of the tool.—3*a*, sectional and side view of a pipe-collar provided with slits, and top view of tool (3). (*See* fig. 24, Plate XIII.)

4. Instrument with hinged spring hooks for lowering wooden or iron pipes into a hole.—Front view and horizontal section; 4*a*, side view.

5. *Spring Hooks*, for lowering pipes.—Front view and horizontal section.

6. *Shear Hook*, for lowering pipes into a bore-hole.—Front view and horizontal section.

7. *Single Hook*, for extracting pipes.—Side view and horizontal section.

8. Instrument used for raising pipes.—Side view and horizontal section.

9, 9*a*. Instrument, provided with movable bill-hooks, for raising wooden pipes.—Two side views with sections, and one horizontal section.

10. Instrument for boring underneath the pipes (out of action).—Side view: 10*a*, side view of the instrument when in action.

11. Instrument used for lowering and raising pipes.—Side view when in action; 11*a*, side view when out of action; 11*b*, horizontal section.

12. Instrument for riveting the junctions of iron pipes.—Side view and partial section; 12*a*, horizontal section.

13. *The* T-*square;* instrument for lowering and extracting wooden pipes.—Front view of instrument supporting a pipe.

14. Mode of raising pipes by means of sand covering a wooden conical block, suspended within the pipes and fitting them.—Vertical section, side view, and horizontal section.

15 to 18. Side and top views of four different hooks for extracting detached or broken boring implements; fig. 15 representing a bill-hook with a detached mud-pump suspended from it.

19. *The Stirrup*, for extracting rods.—Side view and horizontal section.

20. *The Goat's Foot*, also for extracting broken or detached rods.—Side view and horizontal section.

21. *The Single Rope-catch* or *Scraper* (Krätzer).

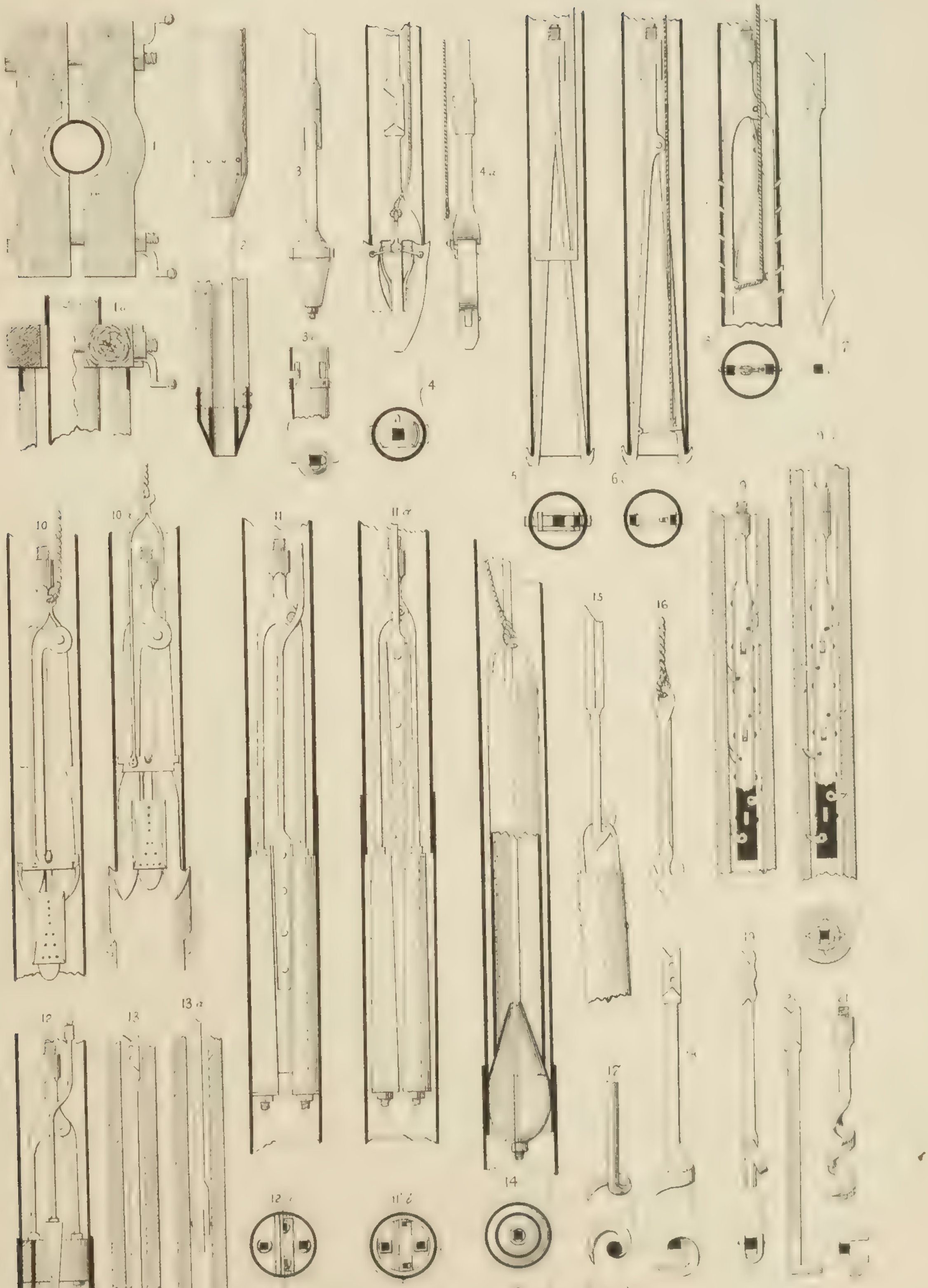
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PLATE XV.

EARTH-BORING.

Figure 1. *Double Spiral Hook* or *Scraper*, for catching and raising broken or detached rods, &c.

2. *The Cross-forked Spring-catch*, with barbed teeth, for extracting portions of boring-tools.

3. *Conical Screw-tap*, for extracting inclined fragments of boring-tools.

4. *Common Screw-tap*, for tapping the male screw of detached rods, &c.

5*a*. *The Fishhook-catch*, for extracting detached ropes, the handle of a mud-pump, &c.

6. *Single Clack-trap*, and Fig. 8, *Double Clack-trap*, as employed for catching rods, &c., underneath any thickened portion on them.

7. *The Forked Cross-hook* for extracting crown-chisels, guides, &c.—Side and top view.

9. *Cross-fork*, armed with movable bill-hooks, for extracting fragments of wooden or iron rods.—Side and bottom view and vertical section.

10. *Single-forked Spring-catch*, spread by a piece of wood, and used for a similar purpose as the tools (figs. 2, 6, 8, and 9).—Side view and horizontal section.

11. *Toothed Fall-shears*, for extracting broken portions of rods and instruments.—Side view, with the shears down; 11*a*, front view, with the shears raised and spread by a piece of wood.

12. *A Water-tester*, for raising samples of fresh water from bottom of boreholes full of brackish water.—Vertical section and top view.

13. *Spherical-headed Pestle*, for puddling water-tight the bottom of a borehole. Side and top view.

14. *A Sketch* showing the mode of lowering wooden or iron pipes by means of a wooden, notched disc.—Vertical and horizontal section.

15. *Hinged Chisel-blades*, spread by means of a screw, for boring underneath the pipes.—15*a*, side view.

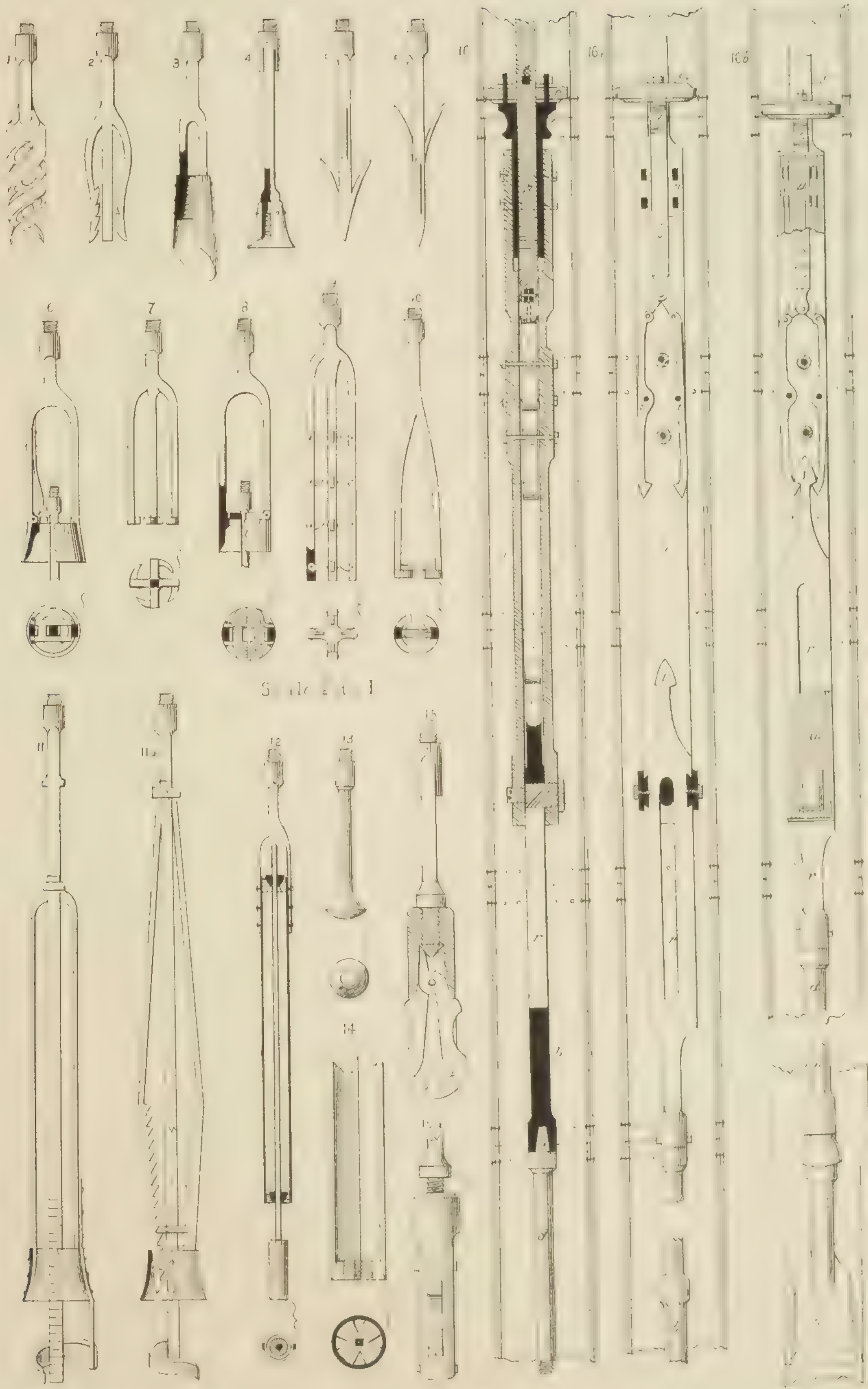
FIGS. 16, *a*, *b*.—KIND'S HYDROSTATIC FALLBORER.

16. Vertical section from front to back, through the axis of the apparatus.

16*a*. Front elevation, with one of the sheath-plates (*a*) removed; borer down at the beginning of the down-stroke.

16*b*. Front elevation, with part of one of the plates (*a*) laid open; borer engaged and near the end of its up-stroke.

- *a a*. *Wrought-iron Plates*, forming the sheath or casing of the apparatus.
- *p*. *Flat Head* of lowest rod of balanced boring-train.
- *o*. *Regulator* or *Parachute*.
- *t, t*. *Cheeks* of wrought-iron, sliding-bars attached to *o*
- *e*. *Stop-key* to regulate the up-stroke of the regulator.
- *l*. *Head of Square Shaft* of the sliding-gear; its upper end is connected with the sliding-bars.
- *i, i'*. *Shear-arms*.
- *s s* *Short-hinged Joints*, connecting the shear-arms with the head (*l*) of the sliding-gear.
- *b*. *Upper Rod* of the falling portion of apparatus, made to slide within the casing (*a a*) by means of slot and key.
- *r*. *Slot*, with flat part of the sliding-rod (*b*).
- *v*. *Spear-shaped* upper end of the sliding-rod (*b*).
- *d b'*. *Main Rod*; *d*, round upper portion of same for the reception of the guide.
- *n*. *Main Chisel*, with wing-blades; two fixed trimming blades on the upper end of the shaft.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The "MEMOIRS OF THE MUSEUM" will be divided into Three Sections:—

SECTION **A.**—DECADES OF THE ZOOLOGY AND PALÆONTOLOGY OF VICTORIA.

SECTION **B.**—GENERAL CATALOGUES OF ALL THE SPECIMENS AND MODELS.

SECTION **C.**—SEPARATE TREATISES ON SUBJECTS ILLUSTRATED BY THE NATIONAL MUSEUM COLLECTIONS.